Turkish Journal of Geriatrics
DOI: 10.31086/tjgeri.2018344059
2018;21(3):438-445

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Received: 08/05/2018
Accepted: 22/07/2018

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Presented at the 11th Academic Geriatric Congress.

RESEARCH

A STUDY ON EFFICACY OF HYDRATION ADMINISTERED BY SUBCUTANEOUS INFUSION IN GERIATRIC PATIENTS

Abstract

Introduction: The study was conducted to investigate the effectiveness of subcutaneous infusion (Hypodermoclysis) in geriatric patients with mild and moderate dehydration.

Materials and Method: This randomized controlled study to determine the efficacy of hypodermoclysis in hydration in a private geriatric care unit included 30 patients, who received both experimental and control administration. Control administration included three intravenous infusions, whereas experimental administration included three subcutan infusions.

Results: Rates of redness, bleeding and agitation were significantly higher at the administration site with intravenous infusion than with subcutan infusion method ($p<0.01$). By subcutan infusion, development rate of edema was significantly lower after the first administration; no edema was observed in the second and third administration. There was a statistically significant difference in the number as well as the duration and insertion times of the catheters used between the two infusion methods ($p=0.001$).

Conclusion: The findings revealed that hypodermoclysis was more effective than intravenous infusion based on the laboratory findings, incidence of side effects, amount and cost of consumables and catheter insertion and duration times. Therefore, hypodermoclysis can be used in mild and moderately dehydrated geriatric patients who need parenteral support.

Keywords: Nursing; Hypodermoclysis; Geriatrics; Fluid therapy

ARAŞTIRMA

GERİATRİK HASTALARDA SUBKUTAN İNFÜZYONLA YAPILAN HİDRASYONUN ETKİNLİĞİNE İLİŞKİN BİR ÇALIŞMA

Öz

Giriş: Çalışma hafif ve orta dehidratasyonu olan geriatrik hastalarda subkutan infüzyon (Hypodermoclysis) uygulamasının etkinliğini incelemek amacıyla yapıldı.

Gereç ve Yöntem: Deneysel ve randomize kontrollü olarak yürütülen araştırma özel bir geriatrik bakım ünitesinde yapıldı. Örneklem 30 hastadan oluştu. Deney ve kontrol uygulamaları aynı hastalar üzerinde gerçekleştirildi. Kontrol uygulamalarında intravenöz yolla üç hidrasyon uygulaması, deney uygulamalarda ise subkutan yolla üç infüzyon uygulaması yapıldı.

Bulgular: İntravenöz yolla yolla infüzyon uygulanan hastaların uygulama alanında kızarıklık, kanama ve ajitasyon görülme oranlarının subkutan infüzyon yönteminden anlamlı düzeyde daha fazla olduğu ($p<0.01$) saptandı. Subkutan infüzyon infüzyon uygulamalarında birinci uygulamada çok düşük oranda ödem gelişti; ikinci ve üçüncü uygulamada ise hiç oluşmadığı görüldü. İntravenöz infüzyon yöntemine göre subkutan infüzyonda kullanılan intraket sayı ve takılış sürelerinin daha az, katater kalış sürelerinin ise daha uzun olduğu belirlendi ($p=0.001$).

Sonuç: Laboratuvar bulguları, yan etki görülme oranları, sarf malzeme miktarı, maliyet, kateter takılış ve kateterin kalış süresi açısından değerlendirildiğinde subkutan infüzyonun intravenöz infüzyona göre daha etkin olduğu; bu nedenle parenteral olarak desteklenmesi gereken hafif ve orta dehidratasyonlu geriatrik hastalarda, subkutan infüzyon uygulamasının kullanılabilir olduğu sonucuna varıldı.

Anahtar sözcükler: Hemşirelik; Hipodermokliz; Geriatri; Sıvı tedavisi

INTRODUCTION

Dehydration is one of the health problems with high morbidity and mortality rates in elderly individuals. Behavioral and physiological mechanisms responsible for body fluid and sodium homeostasis are impaired in aging (1). Natural aging causes a decrease in the intracellular fluid, along with a reduction in total body fluid, renal capacity and decreased thirst sensation. In the presence of these changes along with mental problems, even the intake of minimum amount of fluids can pose a serious health challenge (2,3). Intravenous (IV) route is the only option for treatment of dehydration in patients (refusing to take fluid by oral route, or difficulty in swallowing etc.) when fluid support is not possible by the oral route. However, in older patients, challenges such as finding vascular access, fragility of veins, pulling off the vascular access by patients, infiltration and phlebitis are some of the problems associated with IV infusion for both the patient and the nurse. Conversely, because monitoring, care and chronic disease management of elderly patients are performed at geriatric care centres and homes of the patient outside the hospital, IV treatment is a serious burden and a challenge that requires qualified staff and is costly. The prevalence of dehydration in older patients, high cost and side effects associated with IV infusions have led to a search for a more convenient, faster, more reliable and cost-effective method. Hypodermoclysis (HDC) is subcutaneous (SC) infusion method that was initially introduced 150 years ago (4). HDC is described as SC administration of isotonic fluids and other solutions, which can be effective in the management of dehydration, one of the most important problems of aging populations (5). HDC is based on the principle that fluids are absorbed from SC tissue into the circulatory system through diffusion and perfusion. In the literature, HDC was first mentioned in 1865 as treatment of dehydration in patients with high cholesterol. Since then, HDC has been used for hydration of infants, children, adults and elderly people, especially those with difficult vascular access (4,6,7). Despite the long-term awareness of HDC for over a century, it has not attracted the necessary attention due to insufficient scientific studies and, accordingly, lack of knowledge and experience of nurses; therefore, HDC has not been included in educational programs in a widespread manner. However, HDC can be easily implemented by healthcare staff with minimal training and can be utilized as an efficient method for management of dehydration (4). As studies comparing the efficacy and cost of HDC with IV infusion are lacking, we conducted a randomized controlled study to evaluate the comfort and convenience of HDC in elderly dehydrated patients.

MATERIALS AND METHOD

Design and samples

This randomized controlled study was conducted to examine the efficacy of HDC in geriatric patients with mild and moderate dehydration. This study was conducted at a 41-bed private long-stay geriatric care unit in Istanbul, Turkey and included 30 geriatric individuals fulfilling the following inclusion criteria: age, over 65 years; daily fluid intake, less than 1000 ml; mild-moderate dehydration or elevated risk of dehydration; insufficient fluid intake despite lack of difficulty in swallowing; requirement of parenteral fluid support due to insufficient oral/enteral fluid intake; presence of symptoms of dehydration including dryness of skin, clouding of consciousness, dark urine, scented urine, weakness, loss of appetite, state of sleep and elevated creatinine and sodium levels. Patients with infection, acute dehydration and/or skin problems and edema and those receiving IV medication administration or total parenteral nutrition were not included in the study.

Instruments

Patient identification form had two components: introductory characteristics and questionnaire on health/disease conditions. Specifically, this form collected information on health/disease status such as demographic information and existing diseases, personal history and family history, measurement of arm-calf circumference, nutritional status, diet, fluid intake, urine output, stool output and movement.

Administration monitoring form had several sections. One section collected data on edema, redness, bleeding and agitation that could develop during or after infusion practices. Another section collected information on the use of consumables. In addition, before and after the procedure, data on urine density, pH values and vital signs with duration of the process and number and duration of used materials were collected.

Procedure

Control (IV infusion) and experimental (SC infusion) administration were administered to the same patient. As required by the hydration protocol of the institution that included hydration administration for those with a daily fluid intake of less than 1000 ml and no signs of dehydration, a randomized drawing method was used to determine the order in which the IV method and HDC would be initially used for patients who required hydration therapy. According to the drawing method, patients were divided into two groups of 15 at the start of administration. Therefore, the order of administration methods was predetermined. In this study, three experimental administration and three control administration were performed on the same patient. Thus, 90 experimental and 90 control administration were applied to the sample group included 30 geriatric individuals. Patients who started with IV infusion were initially hydrated with three consecutive IV infusions and were then hydrated with three SC infusions, which were performed with 21–23-gauge SC infusion butterfly needles. For each administration, 1000 ml of 09% salin solution was used after prescription by doctor. Administration rate was 125 ml/hour for SC infusions. All parameters were measured again at the end of the administration. All administrations were performed on abdomen by the researcher, whereas the side effects were evaluated by a nurse, who came from a different institution, which connected of the institution.

Statistical analysis

Data were evaluated by a biostatistician, and IBM SPSS Statistics v. 22 software was used for all statistical analyses. Data were evaluated with descriptive statistical methods as well as the Wilcoxon's signed- rank and McNemar's tests.

Ethical approval

Institutional permission and approval was obtained from Acıbadem University Ethics Board before the start of the study (date, 25 02 2016; decree no: 2016-3/30). For all patients included in the study, consent of the patient and/or legal guardian was requested with the informed volunteer consent form for their voluntary approval to participate in the study.

RESULTS

These patients have Alzheimer's or other types of dementia. Nutrition and dependency status characteristics of all patients are shown in Table 1. 90% of the patients were female, with ages ranging from 65 to 94 years (mean, 81.97±8.81 years). In addition, 66.7% of the patients were dependent for nutritional support, and 60% were dependent for fluid intake support. Only 56.7% of the study cohort were fed orally, and 66.7% of the patients were bed-bound.

Assessment of the incidence rates of side effects according to the infusion route (Table 2) revealed that the rates of redness and agitation were significantly higher with the IV infusion than with the SC infusion ($p<0.01$). After the first administration, redness was observed in ninety percent of the patients who received IV infusion and 23.3% of the patients who received SC infusion, which were significantly different ($p<0.01$). In patients who received hydration therapy with IV infusion, the rates of edema were 20%, 26.7% and 20% in the first, second and third administration, respectively. With HDC, edema occurred only in 20% of the patients during the first administration (Table 2). In patients who received hydration therapy with IV infusion, the rates of bleeding were 86.7%, 63.3% and 70% in the first, second and third administration, respectively, due to leakage or catheter displacement by the patient. However, the rate of bleeding with HDC was below 20%, and the difference between the two groups was significant ($p<0.001$).

Assessment of all three administration revealed that there were significant differences in the number of catheters used and catheter duration and insertion times between the two methods ($p=0.001$). The number of catheters used was lower in HDC compared to IV infusion. The time spent for catheter insertion and duration times were shorter in HDC than IV infusion (Table 3).

Table 1. Patients' demographic and health condition characteristics (n=30).

Characteristics	Groups	n	%
Gender	Female	27	90.0
	Male	3	10.0
Status of dependency for nutrition	Independent	7	23.3
	With help	3	10.0
	Dependent	20	66.7
Nutrition route	Oral	17	56.7
	Enteral	13	43.3
Fluid intake	Independent	8	26.7
	With help	4	13.3
	Dependent	18	60.0
Mobility status	With help	10	33.3
	Bedbound.	20	66.7
Age (mean±sd)	81.97±8.81		

Table 2. Frequency of side effects according to route of infusion.

Side effect conditions		IV	SC	p
	n (%)	n (%)		
Edema in the Infusion Area	1th administration	6 (20.0)	4 (13.3)	0.754
	2nd administration	8 (26.7)	- (-)	
	3th administration	6 (20.0)	- (-)	
	Total	20 (22.2)	4 (4.4)	**0.002**
Redness in the Region	1th administration	27 (90.0)	7 (23.3)	**0.001**
	2nd administration	19 (63.3)	15 (50.0)	0.481
	3th administration	21 (70.0)	14 (46.7)	0.143
	Total	67 (74.4)	36 (40.0)	**0.001**
Bleeding	1th administration	26 (86.7)	6 (20.0)	**0.001**
	2nd administration	19 (63.3)	2 (6.7)	**0.001**
	3th administration	21 (70.0)	3 (10.0)	**0.001**
	Total	66 (73.3)	11 (12.2)	**0.001**
Agitation	1th administration	24 (80.0)	2 (6.7)	**0.001**
	2nd administration	22 (73.3)	5 (16.7)	**0.001**
	3th administration	22 (73.3)	3 (10.0)	**0.001**
	Total	68 (75.6)	10 (11.1)	**0.001**

McNemar Test p<0.01

Table 3. Evaluation of consumed time and material according to hydration method.

	mean±sd (median)	IV	SC	p
		mean±sd (median)		
Number of catheters	**1th** administration	2.033±0.96	1.20±0.41	**0.001**
	2nd administration	2.033±1.00	1.07±0.25	**0.001**
	3th administration	2.67±3.42	1.10±0.31	**0.001**
	Total	2.04±0.97	1.12±0.33	0.001
Catheter duration time (hour)	**1th** administration	18.27±15.85	39.20±12.97	**0.001**
	2nd administration	12.83±11.52	24.87±11.69	**0.001**
	3th administration	14.03±10.70	33.07±12.60	**0.001**
	Total	15.04±12.96	32.38±13.63	0.001
Time spend for catheter insertion **(minute)**	**1th** administration	5.83±2.61	1.90±0.31	**0.001**
	2nd administration	4.77±3.39	1.47±0.51	**0.001**
	3th administration	5.82±4.50	1.60±0.50	**0.001**
	Total	5.47±3.58	1.66±0.48	0.001

Wilcoxon Signed Ranks Test p<0.01

DISCUSSION

Many comorbidities such as Alzheimer's disease, diabetes, hip fractures, heart disease, depression and the presence of four or more chronic diseases are risk factors associated with the disease which cause the elderly to be vulnerable to dehydration (8,9). In addition, medications for the treatment of these diseases may increase the risk of dehydration by disrupting the sensitive fluid and electrolyte balance in this population (2). The mean age of geriatric patients participating in the present study was 81.97±8.81 years (Table 1). In a study of residents in a nursing home associated with the Alzheimer's Foundation, the rates of Alzheimer's disease, diabetes, hip fractures, heart diseases, major depression and ≥4 chronic diseases were 63.3%, 23.3%, 10%, 3.3%, 3.3% and 13.3%, respectively. The characteristics of the sample reflect the appropriateness of the study group. Importantly, unlike younger residents, dehydration is more complex and dangerous in elderly individuals due to widespread dementia and other mental problems; thus, approaches for prevention and treatment of dehydration in geriatric patients are important (3). The most common potential local side effects of SC infusion are edema, redness, pain and ecchymosis (5, 10-12). In HDC, redness, which is the leading cause of inflammation and a symptom of infection, is very limited (5,12,13); edema disappears within a few hours after the termination of infusion; pain is very rare and may occur due to penetration of needle into the muscle or due to tension caused by a large fluid volume. Regarding bleeding, there is minimal risk of puncturing a blood vessel, and bleeding is rare in patients with normal coagulation (4,14). In the current study that investigated the efficacy of HDC for hydration treatment of geriatric patients, IV and SC infusion approaches, which revealed that side effects were significantly fewer with HDC (Table 2). Subcutaneous infusion causes similar but fewer metabolic and hormonal changes compared to IV infusion (15). In a study by Remington and Hultman (2007) which HDC and IV infusion practices were reviewed, HDC was associated with comparable or lower complication rates compared to the IV infusion (2). In the literature, there are also other study findings indicating that subcutaneous infusion is similar to intravenous infusion in terms of side effects (6,16-18). Dasgupta *et al*. reported that fluid treatment-related complications were observed less with HDC, which was an effective and safer approach for both chronic care associated with mild-moderate dehydration and acutely developing conditions, and that HDC could prevents referral of patients to the hospital for rehydration (10). Even in a study on nutrition of elderly inpatients with SC infusion, the rate of major local side effects was lower than that observed with IV infusion (7). The same study also emphasized that SC infusion was tolerated better.

Edema caused by a leakage in the infusion area due to disconnection of catheter outside the vein is one of the most common complications of IV infusion. Edema due to IV infusion is more common in elderly patients and those incompliant with the treatment. However, the rate of edema is very low or absent with HDC (4). In adults, two litres of fluid can be administered in 24 hours without edema using HDC (19). In the current study, the rate of edema at the site of infusion area in HDC was statistically lower, and no edema was observed in the second and third administration with HDC (Table 2). The absence of edema indicated that fluid was absorbed in a sufficient time and that the patient benefited from HDC.

In IV infusion practices, another common complication in the catheter area is redness. It is rarely seen in HDC (19). In the current study, the incidence of redness with HDC was significantly lower in the first administration compared with the IV infusion; although this difference was not statistically significant in the second and third administration, it was still lower compared to the IV infusion (Table 2). This finding is in agreement with other studies (4,10-14).

Albeit rare, bleeding is possible in SC infusion. During or after the IV infusion, agitated or confused

patients can aggravate bleeding due to dislodgement/dislocation of the needle by pulling on the infusion set (4). Bleeding, which is sometimes caused by pulling out the set in order to directly terminate the IV administration, is more common in with IV infusion. The lower incidence of bleeding in the current study reflects the superiority of SC infusion for patient safety and comfort. Bleeding was observed in the infusion area in 2.5% of patients who were administered HDC in a study by Yap *et al*. (20). In the current study, bleeding occurred in the form of ecchymosis with SC infusion. However, comparison of the infusion methods revealed that the rate bleeding/ecchymosis with HDC was significantly lower than that observed with the IV infusion in all three administration (Table 2). Additionally, the fasteners used to complete IV administration without interruption can cause more agitation in the patient. In the current study, the rate of agitation, which was very high with the IV infusion, was significantly lower with HDC when all administrations were assessed (Table 2).

For all patients, but especially in geriatric patients, those in palliative care and oncology patients, IV catheter insertion is a difficult and painful procedure. This is a challenging situation for the nurse because of the pain and uneasiness of the patient and stress caused by loss of time and negativity. Therefore, choosing an appropriate method can eliminate many problems for both the patient and the nurse. SC infusion provides several advantages over infusion via the IV route. In the current study, there were significant differences in catheter insertion and duration times between the two methods (Table 3). Catheters were inserted via the SC route in less than half the time it took for IV insertion, which can enhance the comfort of the patient compared with the IV infusion and positively affect the nursing labour force. With SC infusion, catheter duration time is approximately 2–2.5 times the time with IV infusion, which is suitable for providing a longer duration of hydration. Previous studies reported similar results on the efficacy of HDC. In a study of Slesak *et al*., HDC was superior to IV infusion in patients who were confused and in whom finding an IV vascular access was difficult (18). Remington and Hultman stated that nurses saved time to initiate and maintain due to higher patient comfort, whereas Walsh indicated that HDC was an easier and safer alternative to IV infusion for elderly patients who needed long-term care (2,21).

In the current study, the number of catheters used in IV infusion was significantly higher than that used in the SC infusion (Table 3, $p<0.001$). Catheter cost was also lower with HDC than IV infusion. These findings are also important for healthcare policies in the search for effective, safe and affordable approaches. Similar results demonstrating that HDC might be more affordable were also reported by numerous studies (2,6,13,19-21).

In the current study, edema was not observed, and the incidence rates of side effects such as redness, bleeding and agitation were lower with HDC compared to IV infusion.

In conclusion; in order for the method used to be considered effective, it must be superior in many ways for both the patient and the practitioner, as well as being beneficial and not damaging. Overall, HDC was more suitable in cost and ease of administration according to IV hydration. Patients are less agitated; the risk of infection is low, the application period and the material used are advantageous. These findings lend support to HDC as an easier, cheaper and more cost-effective method for treatment of mild and moderate dehydration in geriatric patients.

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