

Review Article

Personalized nursing reduces local pain and tissue necrosis caused by intravenous drug leakage

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Abstract: Drug leakage-induced injury is a medical emergency that requires immediate treatment. Current research mainly focuses on routine nursing in drug leakage, but little research has been done on the role of personalized nursing in it. Therefore, this study examined personalized nursing for drug leakage patients to explore its effect on local pain and tissue necrosis. Patients with intravenous drug leakage from February 2017 to November 2018 were recruited as the study cohort, which included 75 cases who received personalized nursing (the PC group) and 50 who received routine nursing (the RC group). The time to the resolution of the pain and the wound detumescence and healing were observed, and the risk factors for tissue necrosis were analyzed. The PC group showed a notably shorter time to pain resolution, wound detumescence, and wound healing than the RC group. Diabetes and drug toxicity were independent risk factors for tissue necrosis. Personalized nursing can reduce intravenous drug leakage-induced local pain and tissue necrosis, a finding that is worthy of clinical promotion.

Keywords: Personalized nursing, drug leakage, local pain, tissue necrosis

Introduction

Intravenous infusion is a common clinical treatment, and one of its potential complications, drug leakage, can be divided into extravasation and leakage. The vessel wall is intact at the site of the extravasation, and the leakage is caused by puncturing the vessel wall during puncture. For most types of malignancies, intravenous injection is also the primary method of anticancer drug delivery, with more than one million daily injections worldwide [1]. The incidence of antineoplastic extravasation is reported to be 0.01% to 0.6% [2, 3]. Extravasation injuries begin with local swelling, erythema, blistering, and pain, and may result in severe and progressive tissue damage, including tissue necrosis, and may eventually impede the function of the affected limb and even lead to amputation [4, 5]. Therefore, injuries caused by extravasation are considered medical emergencies requiring immediate treatment [6, 7], and seeking high-quality care is the key to preventing and managing drug extravasation.

Drug leakage not only increases patients' treatment discomfort, it also prolongs the length of the hospital stay and increases the financial burden. Prevention is an ideal treatment method for drug extravasation [8]. With the development of the economy and the continuous improvement of people's living standards, the demand for medical standards, medical means, and medical services is also on the rise. The conventional nursing intervention model cannot keep pace with the needs of most patients [9]. Patients increasingly require personalized nursing, that is, a patient-centered approach to the comprehensive care of their physical and mental health [10]. At present, the clinical application of personalized nursing has also achieved good benefits. Studies have shown that personalized nursing improves the negative emotions of obese patients and has a greater benefit on their health and social functions [11]. Personalized nursing is not only targeted at the disease, it also focuses on the patients themselves. The results of personalized nursing for dying patients with terminal

diseases show that the patients get emotional support, improve their psychological states and pain levels, and the nursing method is also recognized by their families [12].

Currently, there is little research on the application of personalized nursing in drug leakage. Therefore in this study, routine nursing and personalized nursing were carried out for patients with drug leakage during intravenous injection, aiming to study the effect of personalized nursing on drug leakage site injury and the recovery of patients with tissue necrosis.

Materials and methods

Clinical data collection

A total of 125 patients who received intravenous injection and developed drug leakage in our hospital from February 2017 to November 2018 were recruited for this study. Seventy-five of the patients were assigned into the PC group, among which 26 cases had tissue necrosis and received personalized nursing, while the other 50 cases were included in the RC group, among which 18 cases had tissue necrosis and received routine nursing. The patients' clinical data were completely recorded. All the patients were informed and signed the informed consent. The study was approved by the hospital's medical ethics committee.

Inclusion and exclusion criteria

Inclusion criteria: Patients who received intravenous injections and had drug leakage in our hospital, those with complete clinical data, and those who cooperated with the treatment. All the study participants signed the informed consent by themselves or one of their immediate family members signed it on their behalf.

Exclusion criteria: Patients between 18-60 years old, those with mental disorders, severe infections, cognitive impairment, or those bed-ridden for the long term who were unable to take care of themselves.

Nursing methods

The patients in the RC group were given routine nursing, while those in the PC group received personalized nursing, including: (1) Emergency treatment: Needle extraction; Conventional medicinal liquid was applied with 50% magne-

sium sulfate and 75% alcohol (except for the alcohol allergic patients) as a wet compress or a wet heat compress. The residual drug liquid was extracted from the irritant liquid, and an antagonist was used for the local sealing. According to the condition of the extravasation site, local sealing was carried out once every 2-3 days. The personalized nursing also included elevation of the affected limb and replacement of the infusion site. (2) Psychological nursing: Timely communication and counseling were conducted in order to understand the patients' psychological states so as to reduce their psychological pressure and improve their compliance. (3) Health knowledge education: The nursing staff presented information on the effectiveness and safety of extravasation nursing in detail to the patients, informed them of matters needing attention, and reminded them to inform the nurses right away if they feel uncomfortable, so as to improve the patients' cognition. (4) Dietary intervention: We ensured that patients maintain a scientific, balanced, and nutritious diet, which was mainly based on a light and digestible diet while satisfying energy requirements.

Outcome measures

Main outcome measures: The visual analogue scale/score (VAS) was adopted to evaluate and compare the pain levels before and after 48 h of nursing between the two groups. A score of 0 indicated no pain, and the score was in direct proportion to the severity of pain. The times to pain resolution, wound detumescence, and wound healing were compared between the two groups.

Secondary outcome measures: The patients' satisfaction with nursing was compared between the two groups, and the tissue necrosis risk factors were analyzed using a multivariate logistic regression.

Statistical analysis

The statistical analysis of the collected data was performed using SPSS 20.0 medical statistical analysis software (SPSS Corp., Chicago, USA), and the figure rendering was done with GraphPad Prism 7 (GraphPad Software, San Diego, USA). The counting data represented by (%) were verified using chi-square tests and denoted by χ^2 , while the measurement data was expressed as the mean \pm standard deviation.

Table 1. Comparison of the general clinical data in the two groups

Factors	PC group (n = 75)	RC group (n = 50)	t/X ² value	P value
Age (years old)	38.4±14.9	37.8±16.5	1.922	0.056
BMI (kg/m ²)	22.3±1.5	21.9±1.3	0.444	0.658
Smoking history				
Yes	41 (54.67)	28 (56.00)	0.404	0.525
No	34 (45.33)	22 (44.00)		
Diabetes mellitus				
Yes	21 (28.00)	16 (32.00)	0.230	0.631
No	54 (72.00)	34 (68.00)		
Hypertension				
Yes	17 (22.67)	9 (18.00)	0.397	0.529
No	58 (77.33)	41 (82.00)		
Alcoholism history				
Yes	37 (49.33)	25 (50.00)	0.415	0.519
No	38 (50.67)	25 (50.00)		
Residence				
Urban	39 (52.00)	24 (48.00)	0.249	0.618
Rural	36 (48.00)	26 (52.00)		
Leakage type				
Extravasation	69 (92.00)	47 (94.00)	0.180	0.672
Leakage	6 (8.00)	3 (6.00)		
Tissue necrosis				
Yes	26 (34.67)	18 (36.00)	0.023	0.879
No	49 (65.33)	32 (64.00)		
Drug toxicity				
Toxicity	24 (32.00)	17 (34.00)	0.054	0.816
Non-toxicity	51 (68.00)	33 (66.00)		
Infusion mode				
Bolus	31 (41.33)	25 (50.00)	0.911	0.340
Drip	44 (58.67)	25 (50.00)		
Infusion site				
Peripheral venous	55 (66.67)	36 (48.00)	0.027	0.870
Central venous	20 (33.33)	14 (52.00)		
Infusion catheter				
Steel needle	17 (22.67)	10 (20.00)	0.242	0.971
Indwelling needle	45 (60.00)	32 (64.00)		
PICC	11 (14.67)	7 (14.00)		
CVC	2 (2.66)	1 (2.00)		
Infusion duration				
<24 h	39 (52.00)	29 (58.00)	0.435	0.509
≥24 h	36 (48.00)	21 (42.00)		

tion (Mean ± SD). All the measurement data were in a normal distribution, and the inter-group comparisons were performed using independent t-tests and denoted by F. The rank

data was used as the rank sum test, which was represented by Z, and a multivariate logistic regression test was applied to analyze the multifactorial analysis of the drug leakage skin tissue necrosis. P<0.05 was considered to be statistically significant.

Results

Comparison of the general clinical data in the two groups

Though comparable, the patients' general clinical data represented by age, BMI, smoking history, diabetes, hypertension, alcoholism history, residence, type of leakage, tissue necrosis, drug toxicity, infusion method, infusion site, infusion catheter, and infusion duration did not identify any marked difference between the two groups (P>0.05) (**Table 1**).

Comparison of the pain before and after 48 h of nursing in the two groups

The VAS scores in the PC group (6.47±1.32) and the RC group (6.25±1.28) showed no significant differences before the nursing intervention (P>0.05), but the VAS scores in the PC group (1.34±0.24) were notably lower than they were in the RC group (3.78±0.31) after 48 h of nursing (P<0.001), indicating that the pain relief in the PC group was greater than it was in the RC group after the nursing intervention (**Figure 1**).

Comparison of the pain resolution time between the two groups

The comparison of pain resolution time identified that the pain resolution time in the PC group (3.52±2.41) was markedly shorter than it was in the RC group (5.21±3.18) (P<0.05), indicating that compared with routine nursing, personalized nursing can significantly shorten the pain resolution time in patients with drug leakage (**Table 2**).

Personalized nursing and tissue necrosis

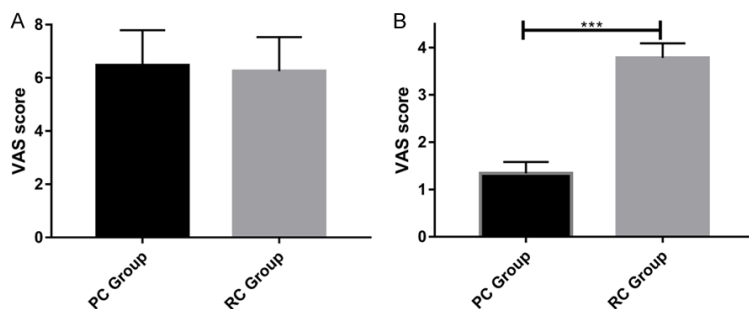


Figure 1. Comparison of the VAS pain scores before and after 48 h of nursing in the two groups: A. There was no significant difference in the VAS scores between the PC group (6.47±1.32) and the RC group (6.25±1.28) before the nursing. B. The VAS scores in the PC group (1.34±0.24) were remarkably lower than they were in the RC group (3.78±0.31) after 48 h of nursing, *** indicates P<0.001.

Table 2. Comparison of the pain resolution times in the two groups

Groups	Pain resolution time
PC group (n = 75)	3.52±2.41
RC group (n = 50)	5.21±3.18
t value	3.375
P value	0.001

Comparison of the wound detumescence time and wound healing time in the two groups

In this section, the time to wound detumescence and wound healing in the two groups of patients are statistically analyzed. The results showed that the wound detumescence time in the PC group (17.52±4.25) was dramatically shorter than it was in the RC group (25.18±5.42) (P<0.001), and the wound healing time in the PC group (6.83±1.15) was remarkably less than it was in the RC group (8.21±1.18) (P<0.001), demonstrating that personalized nursing can dramatically shorten the wound detumescence and healing times of patients with drug leakage (**Figure 2**).

Comparison of the nursing satisfaction in the two groups

By comparing the patients' satisfaction with the nursing work in the two groups, it was found that 23 patients in the PC group were satisfied, 47 were satisfied and 5 were dissatisfied, while 8 patients in the RC group were satisfied, 28 were satisfied and 14 were dissatisfied. The total satisfaction of patients in the PC group (93.34%) was evidently higher than it

was in the RC group (72.00) (P<0.05), indicating that personalized nursing can improve patients' satisfaction with nursing work (**Table 3**).

Univariate analysis of the tissue necrosis

A univariate analysis was performed on the general clinical data of the patients with skin tissue necrosis and those without necrosis. The results exhibited that age, BMI, smoking history, hypertension, alcoholism history, residence, type of

leakage, infusion mode, infusion site, and infusion catheter were not risk factors for drug leakage in the two groups (P>0.05), but diabetes, drug toxicity, and infusion duration were (P<0.05) (**Table 4**).

Multivariate analysis of the tissue necrosis

We included the indicators of the differences from the univariate analysis into the assignment (see **Table 5** for the assignment table), and then selected backward: LR for the multivariate logistic regression analysis. The results revealed that infusion duration was not an independent risk factor for skin tissue necrosis, but diabetes (OR: 1.748, 95% CI: 0.302-10.120) and drug toxicity (OR: 2.553, 95% CI: 0.727-8.727) were (**Table 6**).

Discussion

Venous extravasation is a common and potentially dangerous complication in intensive care units. The nature of the drug also affects the extent of the leakage. For example, the extravasation of vasopressors can lead to serious complications ranging from simple local reactions to skin necrosis and compartment syndrome [13]. In addition, irritants can cause inflammation and pain at the extravasation sites, and extravasation such as 5-fluorouracil and methotrexate may give rise to flare reactions [14]. Drug leakage injuries may reach tendons, nerves, and joints, depending on the location of the vein where the exudation occurs [15]. Therefore, choosing effective nursing methods is of great significance for the

Personalized nursing and tissue necrosis

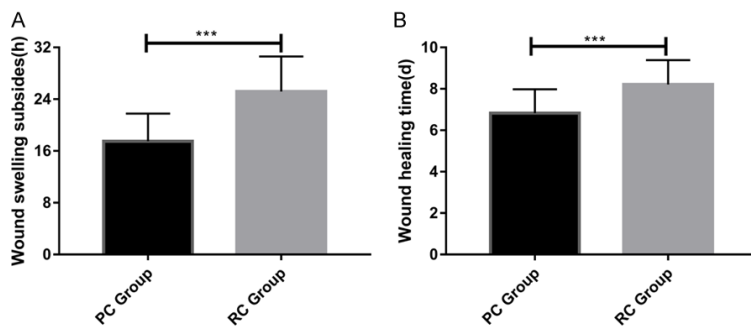


Figure 2. Comparison of the wound detumescence time and wound healing time in the two groups: A. The wound detumescence times in the PC group (17.52 ± 4.25) was notably shorter than they were in the RC group (25.18 ± 5.42). B. The wound healing times in the PC group were significantly shorter than they were in the RC group ($P < 0.001$), *** indicates $P < 0.001$.

Table 3. Comparison of the nursing satisfaction in the two groups

	PC group (n = 75)	RC group (n = 50)	χ^2 value	P value
Very satisfied	23 (30.67)	8 (16.00)	3.46	0.063
Satisfied	47 (62.67)	28 (56.00)	0.556	0.456
Dissatisfied	5 (6.66)	14 (28.00)	10.59	0.001
Total satisfaction	70 (93.34)	36 (72.00)		

treatment of patients with drug leakage. Nursing services can improve the confidence of patients and their families, thus improving their compliance and quality of life after treatment. Effective postoperative nursing is essential for improving the postoperative results of cancer surgery, and for ensuring that neither complications nor any subsequent delay in radiochemotherapy or recovery will occur [16, 17].

Drug leakage not only increases patients' discomfort, it also prolongs the hospitalization time and increases the economic burden. Prevention is the ideal treatment for drug extravasation [18], in which nurses play the key role [19]. The measures to prevent extravasation include a strict adherence to intravenous infusion care regulations to ensure safe punctures, frequent checks for the early signs of infiltration, the monitoring of infusion volume and pump pressure, and the proper education of caregivers on the signs and symptoms of exudation [20]. When an exosmosis injury is diagnosed, the severity should be assessed in time and treated with medication or surgical treatment [21]. First, this study compared the pain of the two groups before the nursing and

48 hours after the nursing. It was found that there was no significant difference in the VAS scores in the two groups before the nursing intervention, but after 48 hours of nursing, the VAS scores in the PC group were much lower than they were in the RC group, indicating that personalized nursing can profoundly reduce pain at the leakage site, alleviate discomfort, and relieve patients' psychological pressure. A comparison of the pain resolution times determined that the time to pain resolution in the PC group was remarkably shorter than it was in the RC group, suggesting that personalized nursing reduced the pain at the patients' leakage sites. In order to further study the recovery effect of personalized nursing on the leakage sites, the wound detumescence time and wound he-

aling time of the two groups were recorded. It was found that the PC group had noticeably shorter wound detumescence times and wound healing times than the RC group. Extravasation can lead to pain, decreased mobility, and permanent soft tissue and tendon injuries, and nursing interventions such as adequate monitoring and early identification remain the best methods for leakage injuries [22]. The results of the personalized nursing after the occurrence of leakage in this study demonstrate that the recovery effect of patients in terms of pain and tissue necrosis is far more superior to routine nursing. When leakage is inevitable, personalized nursing is a good measure for treating the complications caused by leakage.

By comparing the patient satisfaction with the nursing work in the two groups, we found that the total satisfaction rate of the patients in the PC group was significantly higher than it was in the RC group. This also shows that personalized nursing is particularly important for the recovery and follow-up treatment of patients' leakage sites, which can involve many of the patients' health aspects, such as physiology,

Personalized nursing and tissue necrosis

Table 4. Univariate analysis of the tissue necrosis

Factors	Tissue necrosis group (n = 44)	Non-necrosis group (n = 81)	t/X ² value	P value
Age (years old)	37.8±15.7	39.1±16.5	0.428	0.670
BMI (kg/m ²)	22.5±1.3	22.7±1.1	0.910	0.365
Smoking history				
Yes	26 (59.09)	43 (53.09)	0.416	0.519
No	18 (40.91)	38 (46.91)		
Diabetes mellitus				
Yes	31 (70.45)	7 (8.64)	51.49	<0.001
No	13 (29.55)	74 (91.36)		
Hypertension				
Yes	8 (18.18)	18 (22.22)	0.283	0.595
No	36 (81.82)	63 (77.78)		
Alcoholism history				
Yes	23 (52.27)	39 (48.15)	0.194	0.660
No	21 (47.73)	42 (51.85)		
Residence				
Urban	25 (56.82)	38 (46.91)	1.119	0.290
Rural	19 (43.18)	43 (53.09)		
Leakage type				
Extravasation	41 (93.18)	75 (92.59)	0.015	0.903
Leakage	3 (6.82)	6 (7.41)		
Drug toxicity				
Toxicity	39 (88.64)	2 (2.47)	96.04	<0.001
Non-toxicity	5 (11.36)	79 (97.53)		
Infusion mode				
Bolus	18 (22.22)	38 (46.91)	0.416	0.519
Drip	26 (77.78)	43 (53.09)		
Infusion site				
Peripheral venous	31 (70.45)	60 (74.07)	0.189	0.664
Central venous	13 (29.55)	21 (25.93)		
Infusion catheter				
Steel needle	8 (18.18)	19 (23.46)	0.525	0.913
Indwelling needle	28 (63.64)	49 (60.49)		
PICC	7 (15.91)	11 (13.58)		
CVC	1 (2.27)	2 (2.47)		
Infusion duration				
<24 h	30 (68.18)	38 (46.91)	5.199	0.023
≥24 h	14 (31.82)	43 (53.09)		

Table 5. Assignment table

Factors	Assignments
Diabetes mellitus	Yes = 1, no = 0
Drug toxicity	Toxicity = 1, non-toxicity = 0
Infusion duration	<24 h = 0, ≥24 h = 1

psychology, daily diet, postoperative recovery exercise, so as to strengthen the patients' com-

pliance, facilitate the recovery of body function, effectively alleviate their psychological pressure, enormously improve their quality of life, and elevate the nursing satisfaction of patients and their families [23, 24]. The results of this study also revealed that the nursing effect of personalized nursing is superior to that of routine nursing. The reason may be that patients who received personalized nursing were given psychological intervention and health knowledge education, which significantly enhanced the patients' health awareness and compliance, improving the satisfaction of nursing work. Prevention, the continuing education of medical staff, and increasing patients' health knowledge are conducive to reducing the occurrence of drug leakage, and are of particular importance for post-leakage nursing efficacy.

The risk factors of drug extravasation include the nature of the drug input, patient factors and iatrogenic factors, among which the factors of the drug itself include effervescent characteristics, concentration, volume, and the duration of drug exudation [25]. This study also further studied the risk factors of tissue necrosis and collected the general clinical data of patients with skin tissue necrosis and non-ne-

crosis for the univariate analysis. The results demonstrated that there were no marked differences in age, BMI, smoking history, hypertension, alcoholism history, residence, type of leakage, infusion method, infusion site, or infusion catheter between the two groups, but there were statistical differences in terms of diabetes, drug toxicity, and infusion duration, indicating that the latter three are the risk fac-

Table 6. Multivariate analysis

Factors	B	S.E	Wals	Sig.	Exp (B)	Exp (B) 95% CI	
						Upper bound	Lower bound
Diabetes mellitus	0.058	0.896	0.388	0.0533	1.748	0.302	10.120
Drug toxicity	0.937	0.641	2.137	0.144	2.553	0.727	8.727
Infusion duration	-2.123	0.850	6.244	0.012	0.120	0.023	0.633

tors for the drug leakage. We further included the indicators with differences in the univariate analysis for the multivariate logistic regression analysis, and we noticed that the infusion duration was not an independent risk factor for skin tissue necrosis in patients, but diabetes and drug toxicity were. Studies have shown that glucose and lipids are both important components of energy metabolism. Diabetic patients are characterized by their typical dyslipidemia, which is closely related to cardiovascular diseases. Therefore, we hypothesized that patients with impaired glucose and fat metabolism and venous sclerosis were more susceptible to tissue necrosis due to drug leakage.

Although this study has made great progress, it still has certain limitations. Evidence has shown [26] that education and training, which are essential to licensing health care professionals and good clinical practice, are also critical to improving and managing patients, and that education and training between nurses and physicians remains the mainstay of safe chemotherapy management. This study only provided nursing care to patients who had already suffered from drug leakage, but it did not provide personalized nursing before the injection. We hope that in future studies, “pre-emptive”, standardized training for medical staff and pre-injection nursing for patients will be carried out to study the effects of personalized nursing on reducing the incidence of drug leakage.

Conclusion

Personalized nursing can alleviate the local pain caused by intravenous drug leakage and accelerate the recovery of the wound surface in patients with tissue necrosis.

Disclosure of conflict of interest

None.

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Personalized nursing and tissue necrosis

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