ORIGINAL RESEARCH

Factors Associated With Infections From Peripheral Venous Catheters in Older Patients in the ICU and Exploration of Preventive Measures

Jun Yuan, MM; Wenxia Bian, MM; Qinna Hu, MM; Changfang Chen, MM

ABSTRACT

Context • Intensive care units (ICUs) have the highest incidence of hospital-acquired infections. An in-depth understanding of the factors associated with PVIN infections may be the best way to prevent and control PVIN infections.

Objective • The study aimed to investigate the factors associated with peripheral venous indwelling needle (PVIN) infections in older patients in the intensive care unit (ICU) and to use the findings to develop targeted preventive-care measures.

Design • The research team conducted a prospective observational study of factors influencing PVIN infections and a prospective randomized controlled study of targeted nursing care.

Setting • The studies took place at the First Affiliated Hospital, Nanjing Medical University, Nanjing, Jiangsu, China.

Participants • For the first study, participants were 121 patients admitted to the hospital's ICU between April 2018 and June 2020, and for a second analysis, participants were 92 ICU patients admitted between December 2020 and March 2022. The first group took part in an analysis of the factors influencing PFIN infections and the second in a comparison of a targeted nursing intervention and routine care.

Groups • For the first analysis, the research team divided the 121 participants into two groups: (1) a control group with 69 participants who didn't develop a PVIN infection and (2) an observation group with 52 participants who developed a PVIN infection. For the second analysis, the team randomly assigned the 92 participants to one of two groups: (1) 46 participants to a targeted nursing group who received care focused on preventing PVIN infections, and (2) 46 participants to a conventional group receiving routine care.

Outcome Measures • For the first analysis, the research team carried out logistic regression analysis to assess the factors related to PVIN infections, including the incidence of PVIN infections, durations of PVIN retention, ICU stays, and lengths of hospital stay (LOS). For the second analysis, the research team: (1) measured changes in blood glucose and inflammatory factor levels at baseline and postintervention and (2) conducted a nursing satisfaction survey upon patients' discharges.

Results • For the first study, logistic multiple regression analysis revealed that the durations of catheter retention of ≥7d, a number of punctures ≥2 times, a duration of antibiotic administration of ≥14d, and Acute Physiology and Chronic Health Evaluation (APACHE II) scores were independent risk factors for PVIN infections in older patients in an ICU (all $P < .001$). After implementing targeted nursing strategies for the second study, the targeted care group had a significantly lower incidence of PVIN infections ($P < .001$), shorter duration of PVIN retention ($P < .001$), shorter ICU stay ($P < .001$), and shorter LOS ($P < .001$) compared to those of the conventional group. Additionally, the intervention group showed significantly lower fasting plasma glucose (FPG) and 2h postprandial plasma glucose (2hPG) levels, with $P < .001$ and $P = .002$, respectively; significantly lower interleukin-1 beta (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor alpha (TNF-α) levels, with $P < .001$, $P < .001$, and $P = .001$, respectively; and significantly higher nursing satisfaction postintervention ($P = .036$).

Conclusions • The duration of catheterization, antibiotic administration, and APACHE II scores were independent risk factors for PVIN infections in older patients in the ICU. Implementing targeted care based on those factors can effectively prevent PVIN infections in ICU patients and improve patient satisfaction, demonstrating high clinical practicality. (*Altern Ther Health Med.* [E-pub ahead of print.])

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The intensive care unit (ICU) provides the most rigorous care in hospitals. Because the ICU has a high proportion of critically ill patients, who often require mechanical ventilation or a peripheral venous indwelling needle (PVIN), it's also the unit with the highest incidence of hospital-acquired infections.[1,2] The PVIN is an endovascular technique that is now widely used in clinical critical-care medicine.[3] Estrada-Orozco et al's survey found that more than 60% of patients in the ICU require a PVIN.[4] Currently, no uniform clinical guidelines exist for the prevention and care of PVIN infections. Because inserting the PVIN is an invasive operation, inevitably some adverse complications occur, such as mechanical injuries and infections.[5]

Infections

In particular, the complex and critical condition of older ICU patients, the simultaneous involvement of multiple organ functions in their bodies, multiple concomitant immune dysfunctions, and the influence of large doses and types of infused drugs are the main reasons for the increasing incidence of PVIN-related infections.[6]

Milstone et al found that the PVIN, as an invasive mechanical manipulation, can generate a coefficient fibrin sheath on the skin's surface after 1-2 d of retention, which can help pathogenic bacteria to evade the host's phagocytes.[7] Therefore, as the duration of PVIN retention increases, more pathogenic bacteria can accumulate and generate, thus causing an increased risk of infection. Also, as the number of puncture sites increases, the patient's operating site has more contact with the outside world and the risk of tissue exposure within the patient rises, increasing oxidative and inflammatory reactions.[8]

Meanwhile, the occurrence of PVIN infections not only increases the difficulty of treatment but also causes critical complications, such as bacteremia and sepsis, that directly threaten the lives of patients.[9] Fisher et al reported that about 20-30% of older ICU patients die due to PVIN infections.[10] Therefore, how to effectively avoid the occurrence of PVIN infections is an important and difficult question in modern clinical research.

Clinicians consider an in-depth understanding of the factors associated with PVIN infections to be the best way to prevent and control PVIN infections.

Risk Factors

Three studies have analyzed the factors associated with PVIN infections, for example, they found that non-compliance of nurses, elevated peripheral blood cell counts or neutrophils were risk factors for PVIN infection.[11-13] However, use of their findings is limited because the studies were all in a theoretical stage. Although the studies have summarized the risk factors for PVIN infections, none of them have yet initiated further clinical studies to confirm whether prevention of risk factors can reduce the incidence of PVIN infections.

Three other studies found that PVIN infections were correlated with catheter retention time, puncture site, antibiotic administration time, and Acute Physiology and Chronic Health Evaluation (APACHE II) scores.[14-17] Medical practitioners use the APACHE II score as an assessment of the body's reserve resistance to disease, and an increase in the score predicts poor resistance and a higher risk of acquiring infections.[18]

Also, patients with higher scores require more clinical interventions, such as a possible increase in the amount and frequency of nutrient-fluid input, which can also increase the risk of PVIN infections.[19] In contrast, prolonged antibiotic use can lead to increased flora resistance, cause dysbiosis, disrupt the patient's endocrine state, and build an ideal environment for the growth of pathogens.[20]

Targeted Nursing Care

In addition to the targeted treatment of PVIN infection factors, targeted nursing care can repair the deficiencies of previous nursing strategies for ICU patients.[21,22] For example, hospitals can establish nursing teams in the pre-nursing period (before treatment is started after the patient enters the hospital). To enhance the nursing staff's professional competence, the hospital can train the team's members to strengthen their professional knowledge and make them more proficient in the catheterization techniques.

Also, during the whole nursing process, nurses should fully implement aseptic operations, make detailed nursing plans, monitor patients' vital signs, report to physicians when they first find abnormalities, and take emergency life-saving measures.

In the prevention of infections, in addition to the nursing staff's efforts, the hospital should promote health knowledge to patients and their families and ask patients to pay attention to their hygiene and maintain neatness, thus reducing the incidence of infections and decreasing the occurrence of adverse conditions in continuous and uninterrupted monitoring.

Current Study

The study aimed to investigate the factors associated with peripheral venous indwelling needle (PVIN) infections in older patients in the intensive care unit (ICU) and to use the findings to develop targeted preventive-care measures.

METHODS

Participants

The research team conducted a prospective observational study of factors influencing PVIN infections and a prospective randomized controlled study of targeted nursing care. The studies took place at the First Affiliated Hospital, Nanjing Medical University, Nanjing, Jiangsu, China.

For the first study, potential participants were patients admitted to the hospital's ICU between April 2018 and June 2020, and for the second study, participants ICU patients admitted between December 2020 and March 2022. The first group took part in an analysis of the factors influencing PFIN infections and the second in a comparison of a targeted nursing intervention and routine care. These study subjects were our patients who were willing to participate in this study after we asked them.

For both studies, the research included potential participants if: (1) they were aged >60 years, (2) the ICU admission was their first, (3) their PVIN placement and duration of stay was ≥48h, (4) their APACHE II score[17] was >15, and (5) they had no signs of infection prior to their PVIN placement.

The study excluded potential participants if they: (1) had died or been discharged within 2 d of tube placement, (2) had blood-system or immune-system diseases, or (3) had hepatic or renal failure. Patients had incomplete clinical data.

All participants had signed an informed consent form. The ethics committee of the First Affiliated Hospital at

Nanjing Medical University approved the study's protocols. In addition, we registered the trial with the Clinical Trials Registry and will conduct it in strict compliance with the Declaration of Helsinki.

Procedures

PVIN infection assessment. The research team used the Centers for Disease Control and Prevention (CDC)/ National Healthcare Safety Network's (NHSN's) surveillance definition of health-care-associated infections and criteria for specific types of infections in the acute care setting.[23]

Groups. For the first analysis, the research team divided the participants into two groups: (1) a control group that didn't develop a PVIN infection and (2) an observation group that had developed a PVIN infection. For the second analysis, the team randomly assigned participants to one of two groups: (1) the intervention group, a targeted nursing group that received care focused on preventing PVIN infections, and (2) a control group, a conventional group receiving routine care.

Data collection. Clinical data including age, gender, and APACHE II score were collected from the first group of study subjects and logistic regression analysis was performed. Collect the blood glucose and inflammatory factor test results of the second group of study subjects, and investigate their nursing satisfaction, and observe the application effect of the nursing model for the risk factors of PVIN infection.

Routine nursing. Popularize the knowledge of diabetes and pulmonary infection among family members and patients. Give hypoglycemic drugs and anti-infective drugs as directed by the doctor. Closely monitor the indicators of vital signs and understand the changes of the disease. Do a good job in oral care, pipe care and other basic nursing. The nursing staff: (1) spread the knowledge of PVIN and pulmonary infections among family members and patients; (2) gave the patient hypoglycemic drugs and anti-infective drugs as the patient's doctor directed; (3) closely monitored the patient's vital-sign indicators for changes in condition; and (4) provided good oral care, pipe care, and other basic nursing.

Targeted nursing care. The research team developed targeted care strategies to prevent PVIN infections based on factors associated with PVIN infections and previous studies.[24-26] The hospital: (1) established a care management team to provide detailed statistics on patients' conditions and to train nursing staff in their professional competencies; (2) intensified patients' assessment and monitoring prior to PVIN placement, including condition, laboratory tests, vascular status, and medications; and (3) for the choice of puncture site, carefully selected the site of puncture and chose the subclavian vein for puncture as much as possible.

The hospital also: (1) developed standardized operating behaviors, such as thorough and effective hand washing prior to tube placement and use of maximum sterile barriers during tube placement and dressing changes, including sterile caps, gloves, gowns, masks, and sheets to avoid skin-surface invasion via skin tunnels; and (2) identified an 0.5% iodophor solution as the preferred skin disinfectant prior to cannulation.

The research team instructed the nurses: (1) to flush the tube with a heparin solution regularly after placement and to strictly sterilize the connector before the patient received a infusion; (2) during the catheterization period, to change the dressing daily, give the patient's local skin the necessary care, and closely observe for any local inflammatory reactions, such as redness and swelling at the puncture site; (3) for piercing, to select upper-limb veins as puncture sites, avoiding venous valves, joint sites, and veins with scars, inflammation, or hard nodes; (4) to avoid using lower-limb veins for punctures for adults; (5) for patients undergoing radical mastectomy and axillary lymph node dissection, to choose a healthy limb for puncture; (6) to avoid cannulating veins with a history of thrombosis or vascular surgery; (7) at the time of puncture, to place a tourniquet over the puncture point with the skin tensed; (8) after fixing the needle core, to send the outer cuff into the vein, withdraw the needle core; and loosen the tourniquet; (9) to choose a transparent or gauze-type sterile dressing to fix the needle's puncture and indicate the date and add the nurse's signature on the outside of the dressing; (10) to reduce the duration of PVIN, the value of the PVIN should be evaluated daily by the healthcare provider, and the catheter should be removed as soon as possible to minimize the duration of the catheterization when the therapeutic goal is achieved and the condition permits; (11) to use antibiotics appropriately; and (12) to remind patients to inform the healthcare provider promptly in case of abnormal discomfort such as swelling and pain at the puncture site..

For the disinfection requirements, the research team instructed the nurses: (1) to use a skin disinfection range of ≥5cm in diameter at the puncture site of a disposable intravenous infusion steel needle and a skin disinfection range of ≥8cm in diameter at the puncture site of peripheral intravenous indwelling needles, with the disinfection solution drying naturally before puncturing.

For nutritional management, the research team instructed the hospital to formulate a healthy and reasonable dietary nutrition plan according to the patient's needs to replenish the body's required nutrients and enhance the patient's nutritional status.

For the patient's oral care, the research team instructed the nurses to detect the pH value in the oral cavity, select the appropriate mouthwash and clean the oral secretions 2 times/d. For the patient's skin management, the research team instructed the nurses: (1) to encourage patients to develop good personal hygiene habits, bath with warm water, change clothes regularly, and drink more water. (2) to instruct patients to keep their skin clean and dry, (3) to perform local cleaning and disinfection promptly for the skin areas where infection had occurred.

Outcome measures. For the first analysis, the research team carried out logistic regression analysis to assess the factors related to PVIN infections, including the incidence of PVIN infections, durations of PVIN retention, ICU stays, and lengths of hospital stay (LOS). For the second analysis, the research team: (1) measured changes in blood glucose

and inflammatory factor levels at baseline and postintervention and (2) conducted a nursing satisfaction survey upon patients' discharges.

Blood-glucose and inflammatory-factors tests. The hospital's laboratory staff: (1) drew 6 mL of fasting venous blood from the intervention and conventional groups at baseline and postintervention and divided it into two portions for the blood glucose and inflammatory factor tests; (2) used a fully automated biochemistry analyzer (Mindray, Shenzhen, Guangdong, China) to detect blood glucose functions: fasting plasma glucose (FPG) and 2h postprandial plasma glucose (2hPG); and (3) used an enzyme-linked immunosorbent assay (ELISA) (Solarbio, Beijing, China) to detect the inflammatory factors: interleukin-1 beta (IL-1β), interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α).

Nursing satisfaction survey. The research team conducted a nursing satisfaction survey when patients left the ICU, with the survey options of very satisfied, basically satisfied, and dissatisfied. Total satisfaction = (very satisfied + basic satisfaction) number / total number × 100%.

Outcome Measures

Risk factors. The factors examined in the multivariate analysis were age, duration of ICU stay ≥7d, duration of ICU stay ≥7d, catheter retention time ≥7d, number of punctures ≥2 times, antibiotic administration time ≥14d, and APACHE II scores.

Adverse effects. The research team counted the incidence of PVIN infection, oozing blood, catheter shedding, catheter blockage, skin damage, localized thrombosis, and localized swelling and pain.

PVINs. The research team counted patients' PVIN retention time, ICU stay, and length of stay (LOS).

Blood glucose. The research team measured FPG (reference value: 3.9-6.1 mmol/L) and 2hPG (reference value: 3.9-7.8 mmol/L). Diabetes is suspected when the test result is higher than normal, and the higher the result, the more serious the condition.

Inflammatory factors. The research team measured IL-1β, IL-6, and TNF-α. Higher test results for inflammatory factors indicate a more severe inflammatory response.

Statistical Analysis

The research team analyzed the data using the SPSS 22.0 software (IBM, Armonk, New York, USA). The team: (1) expressed the categorical data as numbers (N) and percentages (%s) and compared the groups using a chi-square (χ^2) test, (2) expressed the continuous data as means ± standard deviations (SDs) and compared the groups using the independent samples *t* test, and (3) used logistic regression analysis for correlation analysis. $P < .05$ indicated a significant difference.

RESULTS: RISK FACTORS

Single Factors and Infections

Table 1 shows that no significant differences existed between the control and observation groups in gender, smoking habits, alcohol consumption, and occurrence of diabetes ($P > .05$). The observation group's mean age ($P < .001$) and APACHE II score ($P < .001$) and the number of participants with a duration of ICU stay ≥7d ($P = .003$), a catheter retention time ≥7d ($P = .008$), a number of punctures ≥2 times (.009), and a duration of antibiotic administration ≥14d ($P = .002$), were significantly higher than those of the control group, indicating that the above indicators were the single factors influencing the occurrence of PVIN infections

Table 1. Single Factors Affecting PVIN Infections (N=121)

Influencing Factors	Control Group n = 69 Mean ± SD n (%)	Observation Group n = 52 Mean ± SD n (%)	*t* or χ^2 value	*P* value
Age	67.54 ± 5.61	74.81 ± 5.58	7.073	<.001[b]
Gender			0.259	.611
Male	42 (60.87)	34 (65.38)		
Female	27 (39.13)	18 (34.62)		
Smoking			0.843	.359
Yes	34 (49.28)	30 (57.69)		
No	35 (50.72)	22 (42.31)		
Drink Alcohol			0.173	.677
Yes	24 (34.78)	20 (38.46)		
No	45 (65.22)	32 (61.54)		
Diabetes			0.878	.349
Yes	26 (37.68)	24 (46.15)		
No	43 (62.32)	28 (53.85)		
Duration of ICU Stay ≥7d			9.104	.003[a]
Yes	26 (37.68)	34 (65.38)		
No	43 (62.32))	18 (34.62)		
Catheter Retention Time ≥7d			7.056	.008[a]
Yes	40 (57.97)	42 (80.77)		
No	29 (42.03)	10 (19.23)		
Number of Punctures ≥2 Times			6.751	.009[a]
Yes	10 (14.49)	18 (34.62)		
No	59 (85.51)	34 (65.38)		
Antibiotic Administration Time ≥14d			9.769	.002[a]
Yes	28 (40.58)	36 (69.23)		
No	41 (59.42)	16 (30.77)		
APACHE II Score	18.91 ± 2.25	22.35 ± 3.99	6.010	<.001[b]

[a]$P < .01$, indicating that the numbers of participants in the observation group with a duration of ICU stay of ≥7 d, a catheter retention of ≥7 d, a number of punctures ≥2 times, and a duration of antibiotic administration of ≥14 d were significantly higher than the numbers in the control group
[b]$P < .001$, indicating that the observation group's mean age and APACHE II score were significantly higher than those of the control group

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation; ICU, intensive care unit.

Table 2. Assignment Table

Influencing factors	Assignment
Age	Use raw data for analysis
Duration of ICU stay ≥7d	No = 0; yes =1
Catheter retention time ≥7d	No = 0; yes =1
Number of punctures ≥2 times	No = 0; yes =1
Antibiotic administration time ≥14d	No = 0; yes =1
APACHE II score	Use raw data for analysis

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation; ICU, intensive care unit.

Multiple Factors and Infections

The research team assigned values to the significant univariate indicators in the analysis of single factors (Table 2) and performed a logistic multiple regression analysis with the occurrence of PVIN infections as the dependent variable and the univariate indicators as covariates.

Table 3 shows that age and duration of ICU stay weren't independent risk factors affecting PVIN infections ($P > .05$), but a catheter retention time of ≥7d, a number of punctures

≥2 times, a duration of antibiotic administration of ≥14d, and APACHE II scores were independent risk factors for PVIN infections (all $P < .001$)

Results: Targeted Care

Targeted Care and Adverse Effects

Table 4 shows that PVIN infections occurred for three participants in the targeted care group (6.52%) compared to 11 participants in the conventional group (23.91%). The targeted care group's number of PVIN infections was significantly lower than that of the conventional group ($P = .020$). In addition, other adverse reaction affected eight participants in the targeted care group (17.39%), which was significantly lower than the 19 participants in the control group (41.31%), with $P = .035$.

Targeted Care and PVINs

Table 5 and Figure 1 show that the targeted care group's duration of PVIN retention, ICU stay, and LOS were 9.48 ± 3.49 d, 7.48 ± 2.28 d, and 19.02 ± 4.42 d, respectively, and the conventional group's values were 12.63 ± 2.91 d, 11.28 ± 3.34 d, and 23.72 ± 6.91 d, respectively. The targeted care group's factors were significantly shorter than those the conventional group, at $P < .001$, $P < .001$, and $P < .001$, respectively.

Targeted Care and Blood Glucose

Table 6 and Figure 2 shows that no significant differences existed between the groups in the FPG and 2hPG at baseline ($P > .05$). Postintervention, the targeted care group's FPG and 2hPG were 6.18 ± 0.94 mmol/L and 7.15 ± 1.21 mmol/L, respectively, while the control group's FPG and 2hPG were 6.85 ± 1.08 mmol/L and 8.79 ± 1.12 mmol/L, respectively.

Both groups' FPG and 2hPG levels had significantly decreased between baseline and postintervention, with $P < .001$ and $P < .001$, respectively, for the targeted care group and with $P < .001$ and $P < .001$, respectively, for the conventional group. Postintervention, the targeted care group's FPG ($P = .002$) and 2hPG ($P < .001$) were significantly lower than those of the conventional group.

Table 3. Multiple Factors Affecting PVIN Infections

Influencing Factors	B	S.E.	Wald χ^2	*P* value	OR	95%CI
Age	1.064	0.342	6.873	.164	1.264	0.741-6.812
Duration of ICU stay ≥7d	1.067	0.116	3.843	.340	1.062	0.684-3.008
Catheter retention time ≥7d	1.242	0.694	15.234	<.001[a]	3.420	1.642-9.612
Number of punctures ≥2 times	1.462	1.813	13.164	<.001[a]	2.342	1.841-4.063
Antibiotic administration time ≥14d	0.423	1.364	10.164	<.001[a]	1.713	1.114-2.648
APACHE II score	1.427	0.642	15.168	<.001[a]	2.164	1.412-5.067

[a]$P < .001$, indicating that a catheter retention time of ≥7d, a number of punctures ≥2 times, an antibiotic administration time of ≥14d, and the APACHE II score were significantly positively correlated with PVIN infections

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation; ICU, intensive care unit.

Table 4. Comparison of Adverse Effects Between the Targeted Care and Conventional Groups (N = 92)

Group	PVIN Infection n (%)	Oozing Blood n (%)	Catheter Shedding n (%)	Catheter Blockage n (%)	Skin Damage n (%)	Localized Thrombosis n (%)	Localized Swelling and Pain n (%)	Total Incidence, Except for PVIN Infection n (%)
Conventional group, n = 46	11 (23.91)	4 (8.70)	3 (6.52)	3 (6.52)	3 (6.52)	2 (4.35)	4 (8.70)	19 (41.31)
Targeted care group, n = 46	3 (6.52)	2 (4.35)	1 (2.17)	1 (2.17)	1 (2.17)	1 (2.17)	2 (4.35)	8 (17.39)
χ^2 Value	5.392							4.449
P value	.020[a]							.035[a]

[a]$P < .05$, indicating that the targeted care group's number of PVIN infections and total incidence of adverse effects other than PVIN infections were significantly smaller than those of the conventional group

Abbreviations: PVIN, peripheral venous indwelling needle

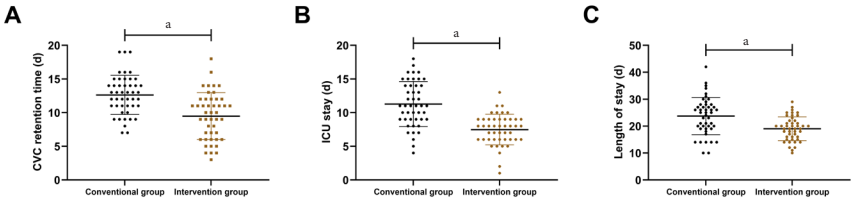
Table 5. Comparison of PVIN Between the Targeted Care and Conventional Groups (N=92)

Group	PVIN Retention, d Mean ± SD	ICU Stay, d Mean ± SD	LOS, d Mean ± SD
Conventional group, n = 46	12.63 ± 2.91	11.28 ± 3.34	23.72 ± 6.91
Targeted care group, n = 46	9.48 ± 3.49	7.48 ± 2.28	19.02 ± 4.42
t value	4.702	6.385	3.884
P value	<.001[a]	<.001[a]	<.001[a]

[a]$P < .05$, indicating that the targeted care group's duration of PVIN retention, ICU stay, and LOS were significantly shorter than those the conventional group

Abbreviations: ICU, intensive care unit; LOS, length of hospital stay; PVIN, peripheral venous indwelling needle ICU.

Figure 1. Impact of Nursing Care on PVIN Infections for the Targeted Care and Conventional Groups. The figure shows comparisons: (1) of PVIN retention time (Figure 1A), (2) of length of ICU stay (Figure 1B), and (3) of LOS (Figure 1C).



[a]$P < .05$, indicating that the targeted care group's PVIN retention time, length of ICU stay, and of LOS were significantly shorter than those of the conventional group.

Abbreviations: ICU, intensive care unit; LOS, length of hospital stay; PVIN, peripheral venous indwelling needle.

Targeted Care and Inflammatory Factors

Table 7 and Figure 3 show that no significant differences existed between the groups at baseline in the inflammatory-factor levels ($P > .05$). Postintervention, the targeted care group's IL-1β, IL-6, and TNF-α were 14.74 ± 2.83 ng/L, 12.74 ± 1.60 ng/L, and 31.23 ± 8.13 ng/mL, respectively, while the

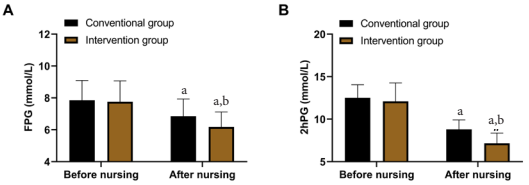
Table 6. Comparison of Blood Glucose Between the Targeted Care and Conventional Groups (N=92)

Group	FPG, mmol/L		Between Periods		2hPG, mmol/L		Between Periods	
	Baseline Mean ± SD	Postintervention Mean ± SD	*t* value	*P* value	Baseline Mean ± SD	Postintervention Mean ± SD	*t* value	*P* value
Conventional group, n = 46	7.85 ± 1.24	6.85 ± 1.08	4.084	<.001[a]	12.50 ± 1.54	8.79 ± 1.12	13.220	<.001[a]
Targeted care group, n = 46	7.76 ± 1.30	6.18 ± 0.94	6.702	<.001[a]	12.10 ± 1.21	7.15 ± 1.21	13.540	<.001[a]
t value	0.308	3.163	.306		1.029	6.733		
P value	0.759	0.002[a]			<.001[a]			

[a]*P* < .05, indicating that both groups' FPG and 2hPG had decreased significantly between baseline and postintervention and that the targeted care group's FPG and 2hPG were significantly lower than those the conventional group postintervention

Abbreviations: 2hPG, 2h postprandial plasma glucose; FPG, fasting plasma glucose

Figure 2. Effects on Blood Glucose of Targeted Care for Prevention of PVIN Infection for the Targeted Care and Conventional Groups. The figure shows comparisons: (1) of FPG (Figure 2A) and (2) of 2hPG (Figure 2B).



[a]*P* < .05, indicating that both groups' FPG and 2hPG had significantly decreased between baseline and postintervention

[b]*P* < .05, indicating that the targeted care group's FPG and 2hPG were significantly lower than those of the conventional group postintervention

Abbreviations: 2hPG, 2h postprandial plasma glucose; FPG, fasting plasma glucose; PVIN, peripheral venous indwelling needle.

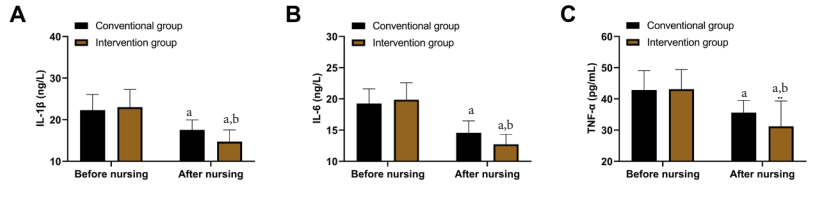
Table 7. Comparison of Inflammatory Factors Between the Targeted Care and Conventional Groups (N=92)

Group	IL-1β		Between Periods		IL-6		Between Periods	
	Baseline Mean ± SD	Postintervention Mean ± SD	*t* value	*P* value	Baseline Mean ± SD	Postintervention Mean ± SD	*t* value	*P* value
Conventional group, n = 46	22.30 ± 3.76	17.57 ± 2.40	7.184	<.001[a]	19.25 ± 2.36	14.55 ± 1.94	10.440	<.001[a]
Targeted care group, n = 46	23.02 ± 4.25	14.74 ± 2.83	11.010	<.001[a]	19.87 ± 2.72	12.74 ± 1.60	15.330	<.001[a]
t value	0.861	5.181	.246		1.168	4.885		
P value	0.392	<0.001*			<0.001*			
Group	TNF-α		Between Periods					
	Baseline Mean ± SD	Postintervention Mean ± SD	*t* value	*P* value				
Conventional group, n = 46	42.86 ± 6.22	35.63 ± 3.93	6.665	<.001[a]				
Targeted care group, n = 46	43.10 ± 6.27	31.23 ± 8.13	7.843	<.001[a]				
t value	0.184	3.309						
P value	0.855	0.001*						

[a]*P* < .05, indicating that both groups' IL-1β, IL-6, and TNF-α had decreased significantly between baseline and postintervention and that the targeted care group's IL-1β, IL-6, and TNF-α were significantly lower than those of the conventional group postintervention

Abbreviations: IL-1β, interleukin-1 beta; IL-6, interleukin-6; PVIN, peripheral venous indwelling needle; TNF-α, tumor necrosis factor alpha.

Figure 3. Impact on Inflammatory Factors of Targeted Care for Prevention of PVIN Infection for the Targeted Care and Conventional Groups. The figure shows comparisons: (1) of IL-1β (Figure 3A), (2) of IL-6 (Figure 3B), and (3) of TNF-α (Figure 3C).



[a]*P* < .05, indicating that both groups' IL-1β, IL-6, and TNF-α had significantly decreased between baseline and postintervention

[b]*P* < .05, indicating that the targeted care group's IL-1β, IL-6, and TNF-α were significantly lower than those of the conventional group postintervention

Abbreviations: IL-1β, interleukin-1 beta; IL-6, interleukin-6; PVIN, peripheral venous indwelling needle; TNF-α, tumor necrosis factor alpha.

Table 8. Comparison of Nursing Satisfaction Between the Conventional and Targeted Care Groups (N=92)

Group	Very Satisfied n (%)	Basically Satisfied n (%)
Conventional group, n = 46	17 (36.96)	16 (34.78)
Targeted care group, n = 46	26 (56.52)	15 (32.61)
χ^2 value		
P value		
Group	Dissatisfied n (%)	Total Satisfaction n (%)
Conventional group, n = 46	13 (28.26)	33 (71.74)
Targeted care group, n = 46	5 (10.87)	41 (89.13)
χ^2 value		4.420
P value		.036[a]

[a]*P* < .05, indicating that the intervention group's total nursing satisfaction was significantly higher than that of the conventional group

control group's IL-1β, IL-6, and TNF-α were 17.57 ± 2.40 ng/L, 14.55 ± 1.94 ng/L, and 35.63 ± 3.93 ng/mL, respectively.

Both group's levels of IL-1β, IL-6, and TNF-α had significantly decreased between baseline and postintervention, with $P < .001$, $P < .001$, and $P < .001$, respectively, for the targeted care group and with $P < .001$, $P < .001$, and $P < .001$, respectively, for the conventional group. Postintervention, the targeted care group's IL-1β ($P < .001$), IL-6 ($P < .001$), and TNF-α ($P = .001$) were significantly lower than those of the control group.

Targeted Care and Nursing Satisfaction

The intervention group's total nursing satisfaction was 89.13% for 41 participants and that of the conventional group was 71.74% for 33 participants (Table 8). The intervention group's nursing satisfaction was significantly higher than that of the control group ($P = .036$).

DISCUSSION

The current research team summarized the risk factors associated with the occurrence of PVIN infection in ICU patients and used them to develop and put into practice targeted care strategies, which are of great importance for future prevention and treatment of PVIN infection. The risk factors were catheter retention time of ≥7d, a number of punctures ≥2 times, a duration of antibiotic administration of ≥14d, and APACHE II scores were all independent risk factors for PVIN infection, which previous studies have supported.[14-16]

In response to current study of risk factors and those of previous studies, the

current research team initially developed targeted care to prevent PVIN infection. Its clinical application demonstrated that the rate of PVIN infection and other adverse reactions; the duration of PVIN retention, ICU stay, and LOS; and the levels of blood glucose and inflammatory factors were all significantly lower in the targeted care group than in the conventional group, indicating that the use of targeted care to prevent PVIN infection had an extremely excellent effect. Medical practitioners can promote the use of this nursing strategy in the ICU in the future to provide patients with reliable safety.

In the current study, patients in the targeted care group also had higher satisfaction with their nursing than the conventional group did. This also demonstrates that the targeted care developed in the current study to prevent PVIN infections was also extremely important for improving the overall quality of health care delivery.

The current study had some limitations. The care protocol that the current research team developed has some room for improvement and optimization. Also, the sample size was small, and in the future, the team should include a larger number of cases to provide representative and comprehensive results. Finally, the research team needs to follow the study's population for a longer period to assess the changes in the prognoses of patients.

CONCLUSIONS

The duration of catheterization, antibiotic administration, and APACHE II scores were independent risk factors for PVIN infections in older patients in the ICU. Implementing targeted care based on those factors can effectively prevent PVIN infections in ICU patients and improve patient satisfaction with care, which has high clinical practicality.

AUTHORS' DISCLOSURE STATEMENT

The authors indicate that they have no conflicts of interest related to the study.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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