Original Article
Preventive effect of cluster nursing on pressure ulcers in orthopedic patients and predictive value of serum IL-6 and TNF-α for the occurrence of pressure ulcers

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Abstract: Objective: To determine the effect of cluster nursing on pressure ulcer prevention and comfort of orthopedic patients. Methods: A total of 124 orthopedic inpatients admitted to the Seventh Affiliated Hospital of Sun Yat-sen University from July 2018 to June 2021 were retrospectively analyzed. Among them, 66 cases received cluster nursing who were assigned into the observation group and the other 58 cases received routine nursing and were assigned into the control group. The incidence of pressure ulcers, the degree of pressure the ulcer, quality of life-brief (QOL-BREF), self-rating anxiety scale (SAS), and self-rating depression scale (SDS) scores of the two groups at 7 days after surgery were compared, and the comfort score and nursing satisfaction of the two groups were evaluated and compared. The expression and predictive value of serum interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α) in patients with pressure ulcers before operation were analyzed via enzyme-linked immunosorbent assay (ELISA). The levels of IL-6 and TNF-α were compared between the two groups before and after nursing. Results: After nursing, the observation group had significantly lower IL-6, TNF-α, SAS score, and SDS scores than the control group, and showed significantly higher QOL-BREF score, nursing satisfaction and comfort scores than the control group. In addition, the observation group showed a significantly lower incidence of pressure ulcers and a significantly lower severity level than the control group after nursing. Patients with pressure ulcers showed significantly higher serum IL-6 and TNF-α levels before surgery, and receiver operating characteristic curve (ROC) showed that IL-6 and TNF-α had certain value in forecasting the occurrence of pressure ulcers. Conclusion: Cluster nursing can substantially lower the incidence of pressure ulcers in hospitalized orthopedic patients and improve their comfort.

Keywords: Cluster nursing, orthopedics, pressure ulcer, comfort level

Introduction

As the social economy and medical levels continuously advance, the average life expectancy continues to rise, and the problem of how to care for an aging population increases [1]. With a large population base and a high proportion of the elderly, the problem of an aging population is particularly prominent in China. Accordingly, the resulting diseases such as stroke, dementia, fracture, and arthritis are on the rise, which poses a great burden on the patients themselves and society [2, 3]. As frequently seen diseases in the elderly, fractures of the distal radius, vertebral compression and

the proximal femur are particularly common [4]. The diseases are primarily caused by older age, poor physical coordination, underlying diseases, severe osteoporosis and poor bone quality of the elderly, as well as slight collisions and falls [5, 6]. At the current stage, surgery is the most effective way to treat fractures in elderly patients [7]. However, the postoperative rehabilitation of patients is closely correlated with postoperative complications, which further determine the prognosis of patients.

Pressure ulcers (PU) refer to a complication caused by being bed ridden for a long-time. Since orthopedic patients often need traction

and fixation or surgical treatment, they have to stay in bed for a long time, and thus face a high risk of PU [8]. Prior research has revealed that elderly patients are a high-risk group for PU with more than 73% of patients with PU aged 65 or above [9]. PU brings a heavy burden to patients' families and society, and also results in adverse prognosis and increase the mortality of patients. Therefore, it is significant to find effective intervention measures to prevent PU [10].

Prevention of PU is a key content in clinical nursing [11]. Conventional operating room-based nursing lacks systematic evaluation of PU, which usually gives rise to misjudgment and missed judgment of it, resulting in aggravation of patients' disease and waste of medical resources [12]. Cluster nursing is based on evidence-based medicine, which applies a series of effective nursing methods and treatment measures to the clinical nursing process. The core of cluster nursing is to combine the concepts of evidence-based medicine with patients' specific conditions to optimize nursing programs in order to solve practical problems in the nursing process [13]. However, at the current stage, no relevant research has proved whether cluster nursing can prevent the formation of PU in orthopedic patients after operation.

Accordingly, this study was designed to analyze the effect of cluster nursing on PU prevention and assess the comfort of orthopedic patients in order to provide a new plan for the clinical prevention of PU.

Methods and data

A total of 124 orthopedic inpatients admitted to the Seventh Affiliated Hospital of Sun Yat-sen University from July 2018 to June 2021 were enrolled and retrospectively analysed. Among them, 66 cases who received cluster nursing were classified as the observation group and the other 58 cases received routine nursing as the control group. This study was performed with permission from the Medical Ethics Committee of the Seventh Affiliated Hospital Sun Yat-sen University, with ethnic approval number of 2021072(A).

Inclusion and exclusion criteria

Inclusion criteria: Patients meeting the 2016 International guidelines for staging of PU [14]; patients with detailed clinical data; patients who had not received surgical treatment; patients without serious skin trauma or other skin diseases; patients with clear consciousness; patients without cognitive dysfunction; and patients who were hospitalized for bone injury for the first time.

Exclusion criteria: Patients comorbid with hypoproteinemia; patients with PU or local infection before operation; patients comorbid with severe malnutrition, cachexia or other diseases; patients in a stage of acute cardio-cerebrovascular adverse events; patients with allergy to the treatment; patients with tumor; or pregnant women.

Nursing scheme

Nursing scheme of the control group: Patients in the control group were given routine nursing, mainly including routine examination, close monitoring of vital signs such as respiratory rate, pulse, heart rate and blood pressure, and exercise guidance.

Nursing scheme of the observation group: (1) Establishment of a cluster nursing group for PU in orthopedic patients: A group nursing plan was developed, and the responsible nurses were given regular training in terms of evaluation of PU and the nursing measures. The problems existing in the nursing process of orthopedic patients with PU were analyzed, and the patients at high risk of developing PU were reported in a timely manner to improve their nursing scheme. (2) Strengthening of the training of team members: Monthly planned training was conducted, which covered risk assessment, PU prevention, PU management, etc. (3) Strengthening of the education of orthopedic patients and their families: Staff was arranged to publicize and educate the causes of PU, the necessity and methods of preventing PU and enhance the enthusiasm of patients to prevent PU. The staff was also arranged to comprehensively analyze the specific situation to provide reasonable and effective preventive measures, inform the patients' families in a timely manner,

asking the patients' families to sign an informed contract, and display a frineldy reminder sign for PU monitoring on the bedside of patients. (4) Regular risk assessment of orthopedic PU: Before implementation of the cluster nursing program, the assessment results were detailed in the PU Nursing Record Form. Nurses gave targeted care to patients according to the evaluation results of patients, and recorded the nursing situations in detail, so as to facilitate verification before the next care. Nurses also informed patients or family members of their skin condition in real time. Additionally, nurses of patients with high risk of developing PU registered, reported, and signed an informed notice and signed a health education evaluation form when the patients were admitted to hospital. (5) Implementation of nursing and preventive measures for orthopedic PU: 1) Relief of local pressure: Nursing staff was arranged to adjust the bed position to raise the head of the bed by about 30°, bend the patients' lower limbs to relieve the shear force in the special areas, and relieve the occurrence of sacrococcygeal PU. The nursing staff were required to have good intervention skills when helping patients turn over, with two nurses giving assistance to avoid strong friction. For patients with PU, air cushion beds were utilized reasonably to fully reduce local skin pressure. 2) Nutritional intervention: Nursing staff was arranged to formulate nutritional recipes for patients to ensure body balance. Patients who could not eat or had difficulty in eating were given enteral nutrition or intravenous nutrition support. 3) Scientific and rational use of protective tools. The nursing staff was arranged to evaluate the patient's condition. Based on the evaluation results, the staff prepared appropriate tools for the patient, equipped the patient with precise instruments and instruments for the special operation site or long operation time, appropriately increased the thickness of the mattress, and used sticky or elastic foam to disperse the pressure on the patient's body. 4) Intraoperative nursing: During the operation, nurses were required to prepare relevant protective equipment, apply proper amount of anti-pressure sore ointment to patients, and provide heat preservation nursing for patients to promote normal blood circulation. 5) Exercise nursing: Patients were not allowe to stay in bed for a long time after surgery. After their physical condition recovered in stages, they were required to have rehabilitation training under the guidance of medical staff, which can effectively improve the rehabilitation effect and reduce the possibility of PU caused by long-term bed rest. 6) Strengthening of skin care: Patients with pelvic fracture usually suffer severe trauma and large blood loss, and are prone to complications such as bladder rupture and urethral injury which increases skin stimulation by sweat, urine and excrement, thus the nursing staff were arranged to scrub their skin frequently. Keeping the skin clean and actively relieving the irritation of urine and excrement are important in preventing bedsores.

Outcome measures

Primary outcome measures: The two groups were compared in terms of the incidence of PU, the degree of PU and the clinical efficacy after treatment. Seven days after operation, the quality of life (QoL) of the two groups was compared. The QoL-brief (QOL-BREF) was used to analyze the postoperative QoL of the two groups [15], which covered physiological factors, psychological factors, social relations and environmental factors. QOL-BREF has a total score of 100 points, and 80 is usually used as critical value in China, with a score of ≥ 90 points for excellence, a score of 80-89 points for medium, and a score ≤ 79 for poor. A higher score suggests better QoL. The self-rating anxiety scale (SAS) and self-rating depression scale (SDS) were adopted to compare the anxiety and depression of patients before (before surgical treatment) and after (postoperative day 5) nursing [16, 17]. Each scale has 20 questions, with the highest score of 80 points and the lowest score of 20 points. A higher score indicates more severe anxiety/depression.

Secondary outcome measures: The clinical data of the two groups were compared, and the comfort degree (including numbness of upper and lower limbs, neck and shoulder pain, emotional tension, etc.) and nursing satisfaction degree of the two groups were compared (the self-made nursing satisfaction questionnaire was used for evaluation, with a score of 81-100 for high satisfaction, a score of 71-80 points for satisfaction, and a score of less than 71 points for dissatisfaction). The levels of serum interleukin-6 (IL-6, PI330) and tumor necrosis factor-α (TNF-α, PT518) in patients before and

Table 1. The clinical data

Factor	Control group (n=58)	Observation group (n=66)	P value
Age			0.835
≥ 60 years old	43	50	
< 60 years old	15	16	
Gender			0.735
Male	36	39	
Female	22	27	
BMI			0.136
≥ 23 kg/m^2	23	35	
< 23 kg/m^2	35	31	
Hypertension			0.242
Yes	28	25	
No	30	41	
Diabetes mellitus			0.859
Yes	15	18	
No	43	48	
Smoking history			0.737
Yes	37	44	
No	21	22	
Braden score	14.63±3.44	15.22±2.98	0.309

Note: Body Mass Index (BMI).

Table 2. Incidence of PU in patients

Group	On the 1st day after operation	On the 5th day after operation
Control group (n=58)	5 (8.62)	14 (24.13)
Observation group (n=66)	2 (3.03)	5 (7.57)
X^2	1.811	6.527
P-value	0.187	0.016

Pressure ulcer (PU).

after treatment were acquired by querying patients' electronic medical records. The levels of IL-6 and TNF-α were compared between the two groups before and after nursing.

Statistical analyses

This study adopted SPSS 20.0 for analysis of the collected data, and GraphPad Prism 8 for illustration of related figures, and the K-S test for analysis of data distribution. The counting data were expressed as percentage (%) and analyzed by chi square test. The measurement data were expressed by mean ± standard deviation. Paired t-test was used for intra-group comparison of data before and after nursing,

and independent sample t-test was used for inter-group comparison of data. Receiver operating characteristic (ROC) curves were drawn to analyze the value of pre-treatment IL-6 and TNF-α levels in predicting the occurrence of PU. P < 0.05 indicated a significant difference.

Results

Clinical data analysis

According to analysis of clinical data between the two groups, there was no significant difference between the two groups in age, gender, body mass index (BMI), Braden score, hypertension history, diabetes mellitus history and smoking history (all P > 0.05, **Table 1**).

Comparison of incidence of PU

According to comparison of the incidence of PU between the two groups, 1 and 5 days after of nursing, there was no significant difference in the incidence of PU between the two groups after 1 day of postoperative care (P > 0.05, **Table 2**), while the control group showed a significantly higher incidence of PU than the observation group after 5 days of postoperative care (P < 0.05, **Table 2**). Among them, there were 6 patients in stage I and 8 patients in stage II in the control group and 2 patients in stage I and 3 patients in stage II in the observation group, so the composition ratio of PU between the two groups was not significantly different (P > 0.05).

Changes of patients' QoL before and after nursing

Before nursing, there was no significant difference in scores of physiological factors, psychological factors, social relations and environmental factors between the two groups (P > 0.05, **Figure 1**). After nursing, the scores significantly increased in patients of both groups (P < 0.05). Further comparison showed that the scores of the observation group were significantly higher than those of the control group after nursing (P < 0.05).

Changes of patients' negative emotions before and after nursing

Before nursing, there was no significant difference between the two groups in SAS and SDS scores (P > 0.05, **Figure 2**). After nursing, SAS and SDS scores of both groups decreas-
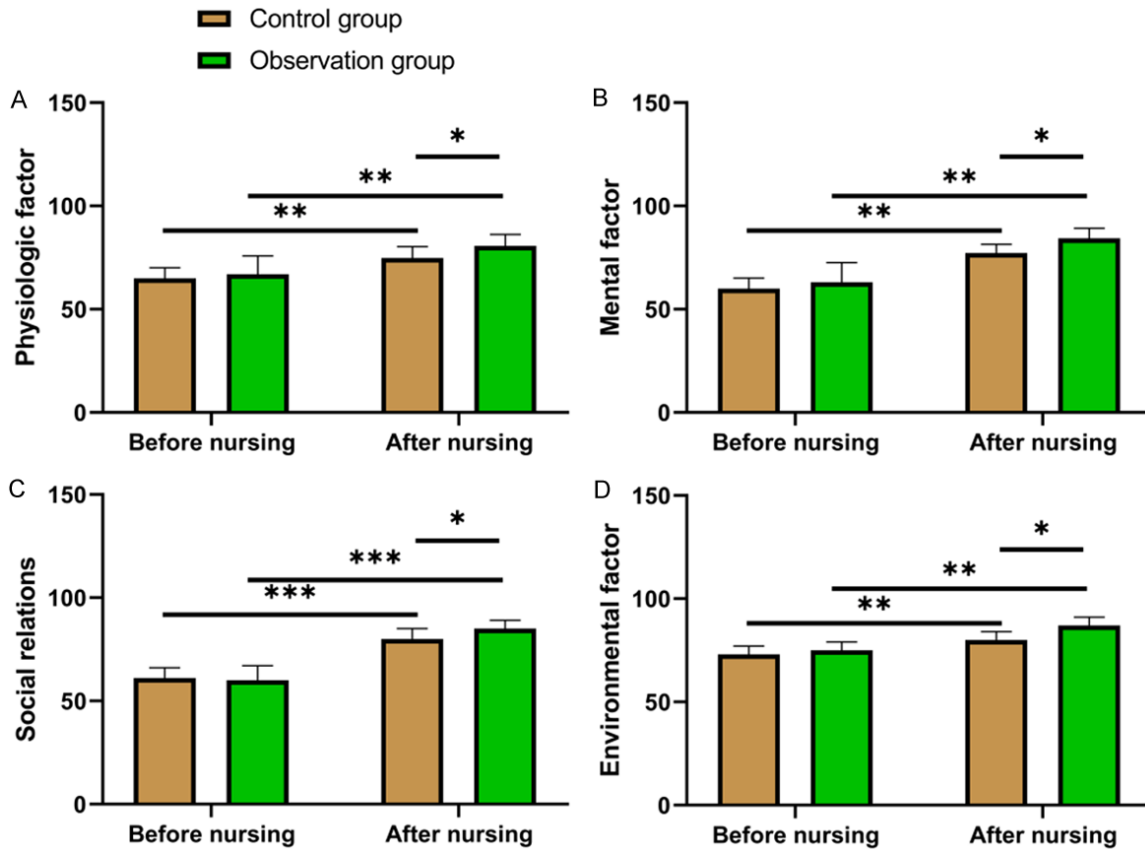
Figure 1. Changes in QOL-BREF score of patients before and after nursing. A. Changes of physiological factor score before and after nursing. B. Changes of psychological factor score before and after nursing. C. Changes of social relation score before and after nursing. D. Changes of environmental factor score before and after nursing. Note: Quality of life-brief (QOL-BREF); *P < 0.05, **P < 0.01, ***P < 0.001.
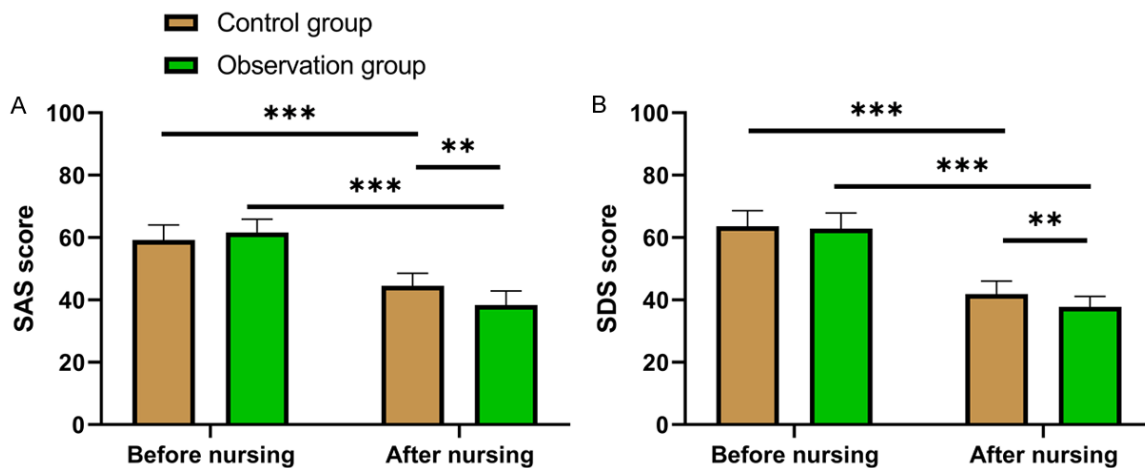

Figure 2. Changes of patients' negative emotions before and after nursing. A. Changes of SAS score before and after nursing. B. Changes of SDS score before and after nursing. Note: Self-rating anxiety scale (SAS), Self-rating depression scale (SDS); **P < 0.01, ***P < 0.001.

ed significantly (P < 0.05). Further comparison revealed that the observation group had signifi- cantly lower SAS and SDS scores than the control group after nursing (P < 0.05).
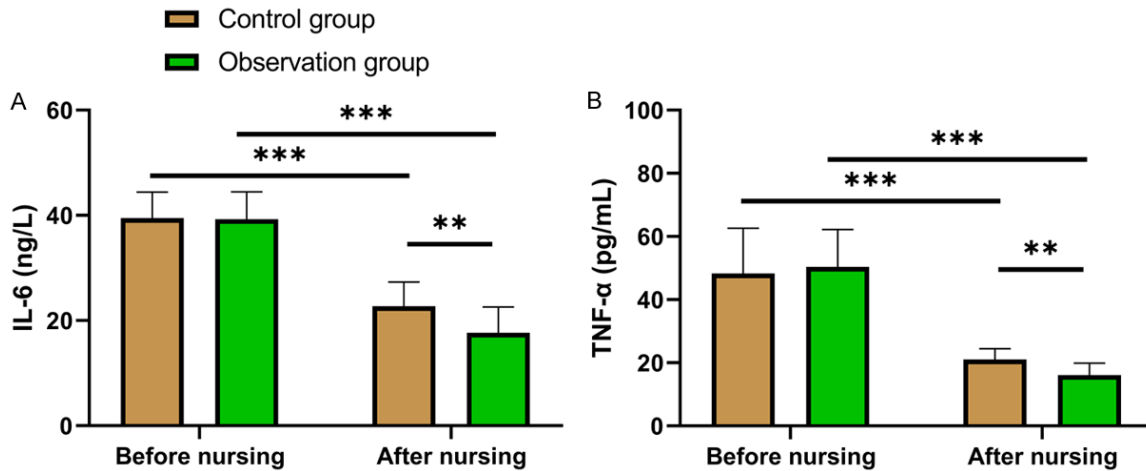
Figure 3. Changes of patients' IL-6 and TNF-α levels before and after nursing. A. Changes of IL-6 score before and after nursing. B. Changes of TNF-α score before and after nursing. Note: Interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α); **P < 0.01, ***P < 0.001.

Table 3. Comparison of complications

Group	Numbness of upper and lower limbs	Neck and shoulder pain	Emotional tension	Total incidence
Control group (n=58)	6 (10.34)	8 (13.79)	8 (13.79)	22 (37.92)
Observation group (n=66)	1 (1.52)	2 (3.03)	1 (1.52)	4 (6.08)
X^2	4.519	4.823	6.914	18.922
P-value	0.035	0.028	0.008	< 0.001

Table 4. Patient satisfaction

Group	Very satisfied	Satisfied	Dissatisfied	Degree of satisfaction
Control group (n=58)	20 (34.48)	28 (48.27)	10 (17.25)	48 (82.75)
Observation group (n=66)	38 (57.58)	27 (40.90)	1 (1.52)	65 (98.48)
X^2				9.444
P-value				0.002

Comparison of changes of IL-6 and TNF-α before and after nursing

Before nursing, there was no significant difference in IL-6 and TNF-α between the two groups (P > 0.05, **Figure 3**). After nursing, the levels of IL-6 and TNF-α in the two groups were significantly decreased (P < 0.05), and further comparison found that the levels of IL-6 and TNF-α in the observation group were significantly lower than those in the control group after nursing (P < 0.05).

Comparison of complications between the two groups

The control group showed a significantly higher incidence of numbness of upper and lower limbs, neck and shoulder pain and emotional tension than the observation group (P < 0.05, **Table 3**).

Comparison of nursing satisfaction

According to comparison of nursing satisfaction between the two groups, the control group expressed significantly higher nursing satisfaction than the observation group (P < 0.05, **Table 4**).

Analysis of the predictive value of IL-6 and TNF-α on pressure ulcers

According to the occurrence of PU, patients were assigned to the occurrence group (n=19) or the no occurrence group (n=105), and the
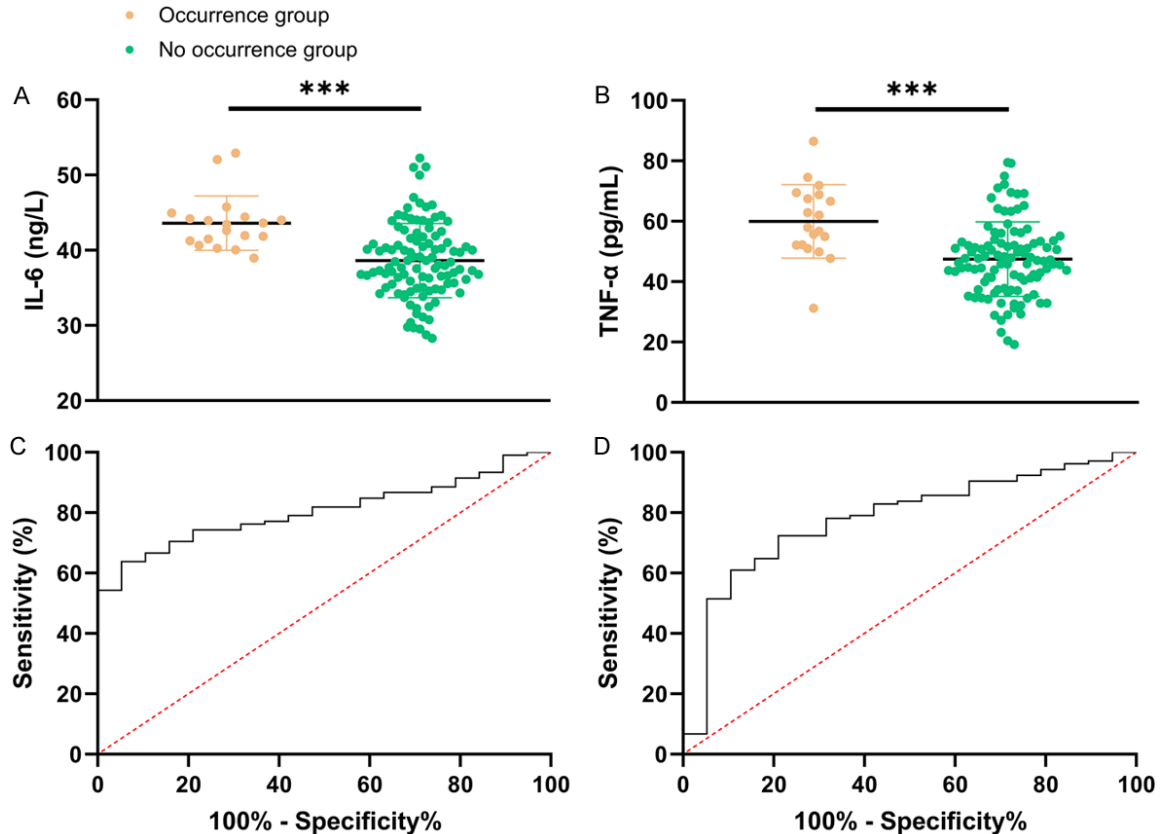
Figure 4. Predictive value of pre-treatment IL-6 and TNF-α levels for PU in patients. A. Expression of pre-treatment IL-6 in patients with PU and those without it. B. Expression of pre-treatment TNF-α in patients with PU and those without it. C. The ROC curve of pre-treatment IL-6 in forecasting the occurrence of PU in patients. D. The ROC curve of pre-treatment TNF-α in predicting the occurrence of PU in patients. Note: Receiver operating characteristic curve (ROC), Interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), Pressure ulcer (PU); ***$P < 0.001$.

pre-treatment IL-6 and TNF-α levels in the two groups were compared. Analysis revealed that the occurrence group showed significantly higher pre-treatment IL-6 and TNF-α expression than the no occurrence group ($P < 0.05$, **Figure 4A**, **4B**). In addition, the ROC curve-based analysis revealed that IL-6 and TNF-α had a certain value in predicting PU in patients with AUC > 0.75 (**Figure 4C**, **4D**; **Table 5**).

Discussion

The orthopedics department is a high-risk area for PU in hospitals [18]. In the traditional mode of PU prevention and intervention, patients are evaluated and cared by the responsible nurses during hospitalization. Improper nursing may lead to the occurrence of PU, and patients are also in a passive participation state due to insufficient education on PU related knowledge [19]. Accordingly, the traditional nursing pre-

vention methods are not unified, and the measures are inconsistent, thus the effect is minimal.

With the improvement of people's QoL, routine nursing can no longer meet the needs of patients. Cluster nursing is based on evidence-based medicine, which applies a series of effective nursing methods and treatment measures to the clinical nursing process. The core of cluster nursing is to combine the concept of evidence-based medicine with patients' specific conditions to optimize nursing programs to solve practical problems in the nursing process [20]. We compared the effect of routine nursing and cluster nursing on PU prevention and comfort of orthopedic patients in the present study, and the results indicated that the patients who received cluster nursing showed a significantly lower incidence of PU and higher comfort than those given routine nursing, suggesting that

Table 5. ROC parameters

Predictive variable	Cut-off value	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Youden index	AUC
IL-6	40.04	63.80	94.70	98.50	32.10	58.50	0.806
TNF-α	52.10	72.40	78.90	95.00	34.10	51.30	0.781

Note: Interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), Area under the curve (AUC), receiver operating characteristic curve (ROC).

clustering nursing can effectively prevent the occurrence of PU in orthopedic patients. Previously, Feng et al. [21] found that PU in orthopedic patients can be effectively prevented through responsibility-based nursing, which is in line with the results of this study. However, compared with the responsibility-based nursing, cluster nursing makes the nursing evaluation plan foreseeably by combining the experience from the past nursing process with current evaluation and strengths the training, giving full play to the advantages of professionals. Moreover, the implementation of PU risk assessment focuses on the observation of high-risk groups, and the implementation of detailed nursing rules for PU prevention can reduce the inducement of PU and lower the incidence of PU.

Postoperative pain and other complications have a serious impact on the patients' psychological state, which compromises their postoperative rehabilitation, treatment compliance and QoL [22]. This study also compared the changes of patients' QoL and negative emotions before and after nursing. In the present study, after cluster nursing, patients had significantly higher life quality scores, and effective relief of postoperative negative emotion than those who had routine nursing. The results showed that cluster nursing can help patients relieve mental stress and improve their treatment cooperation by strengthening health education, psychological counselling and dietary guidance. In addition, the cluster nursing intervention measures are more flexible and targeted, and thus can better prevent and deal with the nursing problems existing in clinical treatment to deliver a better nursing effect.

Reportedly, after the occurrence of PU, deep ulceration occurs in local wounds, triggering suppuration, infection, fever and even systemic reactions [23]. TNF-α and IL-6 take play a crucial role in this process. IL-6 is produced by various types of cells, which can interact with other cytokines to participate in the inflammatory reaction, and act on various target cells. It is the primary pro-inflammatory cytokine and a major inflammatory mediator of the systemic inflammatory response syndrome [24]. Produced by macrophages and T cells, TNF-α exists in the form of trimer. It affects the process of inflammation, causes severe tissue injury and disturbance of blood circulation, and is a pathogenic factor of shock and organ failure [25]. Taradaj et al. [26] found that the serum levels of IL-6 and TNF-α in patients increased significantly after the onset of PU, and their serum levels of IL-6 and TNF-α and inflammation were significantly inhibited after laser treatment. This indicates that the two are implicated in the occurrence of PU. In this study, we found that the serum levels of IL-6 and TNF-α in the observation group were significantly lower than those in the control group, suggesting that cluster nursing is beneficial to the inhibition of the inflammatory response in patients. In addition, according to ROC curve-based analysis, the AUCs of IL-6 and TNF-α in predicting PU were > 0.75, indicating their good performance in predicting PU.

Through analysis, we determined that cluster nursing can effectively prevent the formation of PU in orthopedic patients and found that TNF-α and IL-6 can be used as potential indicators to predict the formation of PU. However, there are still some limitations in this study. First of all, we were unable to conduct follow-up of the patients due the retrospective nature, so it is still unclear whether the cluster nursing mode is beneficial to the long-term treatment effect of patients. Secondly, due to the retrospective nature, the results may be biased. Therefore, we hope to carry out prospective clinical studies in the future to improve our results.

To sum up, cluster nursing can substantially lower the incidence of PU in hospitalized orthopedic patients and improve their comfort.

Disclosure of conflict of interest

None.

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