Am J Transl Res 2025;17(6):4804-4817
www.ajtr.org /ISSN:1943-8141/AJTR0165605

Original Article

Effects of standardized nursing protocol on nursing quality and complications in pediatric patients with massive scalp hematoma undergoing negative pressure drainage

Wei Song, Fei Di, Mingxing Wu, Qiaoying Li, Jie Jia

Department of Neurosurgery, Children's Hospital Affiliated to The Capital Institute of Pediatrics, Beijing 100020, China

Received April 24, 2025; Accepted May 24, 2025; Epub June 15, 2025; Published June 30, 2025

Abstract: Objective: To investigate the effect of standardized nursing process intervention on care quality and complications in children with large scalp hematomas treated with modified negative-pressure drainage. Methods: This prospective randomized controlled study was conducted in the Children's Hospital Affiliated with the Capital Institute of Pediatrics. A total of 102 children with massive scalp hematoma were randomly assigned to a control group (n = 52, with conventional nursing care) and an observation group (n = 50, with standardized nursing care). Drainage time, hematoma subsidence time, and nursing-related outcomes were compared between the two groups. Hematologic data were assessed preoperatively, and at 24 h and 72 h postoperatively. Results: Compared to the control group, the observation group exhibited significantly shorter drainage time, hematoma resolution time, wound healing time, and hospitalization time (all $P<0.05$), as well as lower hospitalization cost ($P<0.05$). Rehabilitation outcomes were significantly improved across age groups (all $P<0.05$), with lower pain scores (all $P<0.05$), reduced complication and readmission rates (all $P<0.05$), higher quality-of-care scores (all $P<0.05$), and greater nursing satisfaction ($P<0.05$). At 24 h after operation, the observation group had higher levels of hemoglobin (Hb) and fibrinogen (Fib) ($P<0.05$), and lower levels of prothrombin time (PT), activated partial thromboplastin time (APTT), C-reactive protein (CRP), pro-calcitonin (PCT), and white blood cell count (WBC) ($P<0.05$). Conclusion: Implementation of standardized nursing processes significantly improves care quality, reduces complications, and promotes faster recovery in pediatric patients undergoing modified negative-pressure drainage for large scalp hematoma, supporting its broad application in clinical practice.

Keywords: Scalp hematoma, modified negative-pressure drainage, standardized nursing process, quality of nursing care

Introduction

Scalp hematoma is a prevalent condition in neonates and children, predominantly resulting from birth canal compression or blunt trauma [1]. Based on anatomic location, scalp hematomas are classified into three categories: subcutaneous, subgaleal, and subperiosteal [2]. Small hematomas often resolve spontaneously within 1-2 weeks and generally require no specific treatment [3]. However, large, non-absorbable, and massive scalp hematomas, such as most subgaleal hematomas, may lead to complications such as secondary infections, ossification, cranial bone destruction, and, in severe cases, hypovolemic shock if not drained in a timely manner [4-6]. Consequently, modified negative-pressure drainage is commonly employed for the clinical management of massive scalp hematomas [7, 8]. Nonetheless, modified negative pressure drainage carries risks including drain tube obstruction and inadequate evacuation of hematoma fluid, which may lead to secondary infection, abscess formation, and delayed recovery, particularly in the absence of effective nursing interventions [9]. Conventional nursing practice, which adheres to passive implementation of physician orders, may delay the identification and management of complications, thereby impair-

https://doi.org/10.62347/TCZH5661

ing recovery [10]. Consequently, optimized nursing models are imperative to enhance care quality and reduce complication rates.

The standardized nursing process is a contemporary, evidence-based nursing approach designed to minimize perioperative complications and stress responses. It involves structured and proactive care strategies that have demonstrated safety and efficacy in clinical application [11, 12]. This study aims to investigate the effect of a standardized nursing process on care quality and complication rates in pediatric patients with large scalp hematoma undergoing modified negative pressure drainage. The primary objective is to enhance the nursing outcomes and overall care quality. The secondary objective is to establish a more scientific and effective nursing protocol for clinical nursing practice.

Materials and methods

Sample size estimation

Sample size was calculated using PASS 15.0 software based on the effect size method. With an expected medium effect size ($d = 0.60$), a significance level of $\alpha = 0.05$, and a power of $1 - \beta = 0.8$, the minimum required sample size for a two-group independent samples t-test was determined to be 45 participants per group. Considering a possible 10% dropout rate, a minimum of 50 cases per group was required, for a total of at least 100 cases.

Participant characteristics

In this prospective randomized controlled trial, a total of 104 children diagnosed with large scalp hematomas and scheduled for modified negative-pressure drainage were admitted to the Neurosurgery Department of the Children's Hospital affiliated to the Capital Institute of Pediatrics between May 2022 and May 2024. These patients were randomly divided into a control group (n = 52, routine care) and an observation group (n = 52, standardized care). Two participants in the observation group withdrew, yielding a final sample of 102 patients, including 52 cases in the control group and 50 cases in the observation group. The control group comprised 25 males and 27 females with an average age of (7.00 ± 2.47) years; the observation group included 26 males and 24 females with an average age of (6.92 ± 2.48) years. The study was approved by the Medical Ethics Committee of the Children's Hospital affiliated to the Capital Institute of Pediatrics (SHERLL2024046).

Inclusion and exclusion criteria

Inclusion criteria: ① Diagnosis of scalp hematoma confirmed by cranial CT; ② Indication for treatment with modified negative-pressure drainage; ③ Informed consent obtained from patients' guardians.

Exclusion criteria: ① Severe heart, hepatic, or renal dysfunction; ② Presence of cardiovascular, cerebrovascular, or pulmonary diseases; ③ Cognitive impairment; ④ History of drug allergy; ⑤ Intolerance to or contraindications for modified negative-pressure drainage; ⑥ Concurrent use of other treatment modalities that may confound therapeutic evaluation; ⑦ Incomplete treatment due to personal reasons.

Modified negative-pressure drainage

All patients underwent modified negative-pressure drainage. Patients were positioned appropriately, and head fixation was ensured. The hematoma site and its surrounding skin were routinely disinfected using 0.5% iodine solution. Sterile fenestrated drapes were applied, and the procedures strictly adhered to aseptic protocol.

The puncture site was selected at the lowest point of hematoma fluctuation. A handheld venous puncture needle was used to puncture through the skin and advance 0.5-2.0 cm into the subcutaneous tissue until the hematoma cavity was accessed. Blood was then slowly aspirated. Once aspiration was complete, the needle was fixed in place. A transparent sterile dressing was applied at the puncture site, covered with sterile gauze, and the end of the needle was connected to a disposable infusion set, which in turn was connected to a negative-pressure device to initiate continuous drainage.

Implementation of care programs

Control group: Patients in the control group were given routine nursing care, including monitoring of vital signs, observation of drainage tubes, administration of prescribed medica-

tions, preparation of emergency equipment, and adherence to aseptic techniques to prevent infections.

Observation group: (1) Admission nursing: *Medical history and health education:* Upon admission, nursing staff obtained a detailed medical history including past illness, allergies, and family genetic conditions to comprehensively assess the patient's condition. Patients and families were educated on disease etiology, symptoms, treatment options, and prognosis to reduce their anxiety. *Examination preparation:* Patients and caregivers were informed about procedures such as B ultrasound, CT, and MRI, including pre-exam preparations and positional requirements. Caregivers were guided to assist in calming and positioning the child to ensure smooth examination and accurate results. *Psychological support:* Nurses observed the emotional state of caregivers and provided timely counseling for anxiety or depression. Communication and reassurance, including sharing successful cases, were used to improve caregiver confidence and support treatment compliance.

(2) Preoperative care: *Scalp preparation:* Hair removal was performed gently using surgical scissors per standardized protocols to ensure a clean field and avoid scalp injury. The purpose and significance of skin preparation were explained to families to encourage cooperation. *Surgical preparation:* Nurses assisted in preparing surgical instruments, dressings and medicines, confirmed equipment functionality, ensured proper patient positioning, and safeguarded comfort and safety prior to surgery.

(3) Intraoperative care: *Vital signs monitoring:* Heart rate, blood pressure, respiration rate and other vital signs were continuously monitored using a cardiac monitor. Abnormalities, such as sudden drop in heart rate or blood pressure, were promptly reported to physicians, and emergency support was provided when needed. *Surgical assistance:* Nurses assisted surgeons with sterile technique, passed instruments accurately, and helped with drainage tube placement and fixation to minimize infection risks and ensure procedural success.

(4) Postoperative care: *Pain management:* Pain care plans were tailored to patients' condition and pain level. Cognitive distractions (e.g., cartoons, storytelling) were used for mild pain, while analgesics were administered for moderate-to-severe pain as prescribed. Adverse effects (e.g., respiratory depression, nausea) were monitored and reported for prompt adjustment. *Hematoma monitoring and bacterial culture:* Hematoma size, color and consistency were regularly assessed. Blood from the drainage site was cultured to detect infection; if positive, antibiotic therapy was adjusted based on sensitivity results. *Drainage tube care:* The drainage tube was inspected daily for secure fixation. Drainage device function, negative pressure stability, and tube patency were checked regularly. Drainage volume and characteristics were documented; abnormal changes were reported immediately. *Scalp cleaning and disinfection:* Postoperative scalp hygiene was maintained, with gentle disinfection around the wound to prevent irritation. Skin color and signs of poor perfusion (e.g., pallor, cyanosis) were monitored to determine the need for reintervention. *Positioning care:* Head elevation was encouraged to reduce swelling and improve venous return. Patients were repositioned every 2 hours to prevent pressure sores and avoid dislodging the drainage tube. *Eye protection:* Sterile saline swabs were used to clean around the eyes during head care to prevent disinfectant-induced conjunctival irritation. Any accidental exposure was immediately flushed, and abnormalities were referred for ophthalmologic evaluation. *Special care for newborns:* Newborns received additional care, including gentle cleansing of vernix caseosa using warm water and soft cloths, and tailored feeding guidance based on weight and age to ensure adequate nutrition and promote growth.

Nurse-patient communication and relationship maintenance

Nurses provided detailed explanations of disease, treatment plan, and prognosis to family members to address concerns and reduce misunderstandings. Regular communication about patient status and treatment progress was maintained, and family feedback was respected during care planning. These efforts aimed to enhance satisfaction, strengthen the nurse-patient relationship, and minimize disputes.

Outcome measures

(1) *Clinical Recovery Indicators:* Drainage duration, time to hematoma resolution, and wound

healing time were recorded and compared between the two groups [13].

(2) *Hematologic and Inflammatory Markers:* Hemoglobin (Hb), prothrombin time (PT), activated partial thromboplastin time (APTT), fibrinogen (Fib), C-reactive protein (CRP), pro-calcitonin (PCT), and white blood cell count (WBC) were measured preoperatively, and at 24 and 72 hours postoperatively in both groups [14].

(3) *Postoperative complications and Readmission:* The incidence of postoperative complications, including calcification, secondary infection, scalp necrosis, and cranial deformity, as well as readmission rate were recorded and compared between the two groups of patients [15]. Complication and readmission rates were calculated as follows: Rate (%) = (Number of cases/Total number of patients) × 100%.

(4) *Hospitalization Metrics:* Length of stay and total hospitalization costs were documented and compared between groups [16].

(5) *Pain Assessment:* At 48 h postoperatively, pain was assessed using the FLACC (Face, Legs, Activity, Cry, Consolability) scale [17], which evaluates five behavioral domains, each scored from 0 to 2. The total score ranges from 0 to 10, with 0 indicating no pain, 1-3 indicating mild pain, 4-6 indicating moderate pain, and 7-10 indicating severe pain.

(6) *Quality of Care Evaluation:* On the day of discharge, nursing quality was scored using a standardized quality of care evaluation scale, which included four domains, namely, disease understanding, risk assessment, drainage tube maintenance, and nurse-patient communication, with 25 points for each item with a total of 100 points. Higher scores indicated better care quality [18].

(7) *Nursing Satisfaction:* Family-reported satisfaction with nursing care was assessed using a 20-item questionnaire (5 points per item, total score: 100) on the day of discharge [19]. A score <70 indicated dissatisfaction, 70-89 indicated satisfaction, and ≥90 indicated high satisfaction. The satisfaction rate = (very satisfied + satisfied)/total number of cases × 100%.

Statistical methods

Data were analyzed using SPSS 27.0, and graphical representations were generated using GraphPad Prism 8.0. Continuous variables conforming to a normal distribution were expressed as mean ± standard deviation ($\bar{x} \pm s$) and compared between groups using independent samples *t*-test. Non-normally distributed data were expressed as [M (Q_1, Q_3)] and analyzed using the Kruskal-Wallis H test. Repeated measures analysis of variance (ANOVA) was applied to compare hematologic indices across different time points within each group. Age group comparisons were performed using multiple t-tests, with the Holm-Sidak method applied to correct for multiple comparisons. Counted data were expressed as [*n* (%)] and analyzed using the chi-square test. A P value <0.05 was considered significant.

Results

Comparison of baseline data between the two groups

There were no significant differences in baseline characteristics, including gender, age, hematoma site, or cause of disease, between the two groups (P>0.05), indicating comparability (**Table 1**).

Comparison of hematologic data between the two groups

Preoperatively, there were no significant differences in Hb, PT, APTT, Fib, CRP, PCT, or WBC between the two groups (P>0.05). At 24 h postoperatively, Hb and Fib levels were significantly higher in the observation group than in the control group (P<0.05), while PT, APTT, CRP, PCT, and WBC levels were significantly higher in the control group (P<0.05). At 72 h postoperatively, significant differences persisted in Hb, CRP, PCT, and WBC, whereas PT, APTT, and Fib showed no significant intergroup difference (P>0.05) (**Table 2**).

Comparison of rehabilitation indicators between the two groups

In the observation group, the average drainage duration was (4.37 ± 0.27) d, the average hematoma resolution time was (7.23 ± 0.69) d, and the mean wound healing time was (11.23 ± 2.35) d. The time for these data in the control group was (4.55 ± 0.44) d, (9.51 ± 1.80) d, and (15.78 ± 2.47) d, respectively. All three indicators showed significantly faster recovery in the

Table 1. Comparison of baseline data between the two groups [n (%)] ($\bar{x} \pm s$)

Item	Observation group (n = 50)	Control group (n = 52)	t/χ^2	*P*
Gender			0.157	0.692
Male	26 (52.00)	25 (48.08)		
Female	24 (48.00)	27 (51.92)		
Age (years)	6.92 ± 2.48	7.00 ± 2.47	-0.163	0.871
Hematoma site			1.986	0.371
Subgaleal	26 (52.00)	22 (42.31)		
Subperiosteal	21 (42.00)	23 (44.23)		
Other	3 (6.00)	7 (13.46)		
Causes of disease			2.937	0.401
Birth injuries	21 (42.00)	23 (44.23)		
Sharp force injuries	10 (20.00)	16 (30.77)		
Bump injuries	15 (30.00)	9 (17.31)		
Other	4 (8.00)	4 (7.69)		

observation group compared with the control group ($P<0.05$) (**Figure 1**).

Comparison of hospitalization time and expenses between groups

The observation group had a significantly shorter mean hospital stay (4.64 ± 1.60) d, and lower hospitalization expense (1855 ± 545.5) yuan compared to the control group ((6.48 ± 1.24) d; (2250 ± 475.30) yuan, respectively) (both $P<0.05$) (**Figure 2**).

Comparison of rehabilitation indicators between the two groups stratified by age

Patients in both groups were stratified into three age ranges: <4 years, 4-8 years, and >8 years. In the <4 years group, the scalp hematoma resolution time was significantly shorter in the observation group compared to the control group ($P<0.05$), while no significant differences were observed in drainage duration, wound healing time, or hospitalization time ($P>0.05$). In the 4-8 years group, the scalp hematoma resolution time, wound healing time, and hospitalization time of patients in the observation group were considerably less than those of the control group ($P<0.05$); however, there was no obvious difference in the drainage duration between the two groups ($P>0.05$). In the >8 years group, the drainage time, hematoma resolution time, and wound healing time were shorter in the observation group than in the control group ($P<0.05$), whereas hospitalization time did not differ significantly ($P>0.05$) (**Figure 3**).

Comparison of pain scores between groups

Prior to intervention, no significant differences were observed in each FLACC subscale score or total scores between the groups ($P>0.05$). Following the intervention, the observation group showed considerably lower scores across all subscales as well as the total scores compared to the control group ($P<0.05$) (**Table 3**).

Age-stratified analysis of FLACC scores revealed that in the 4-8 year and >8 year age groups, the observation group had significantly lower scores in all FLACC subscales and total scores compared to the control group ($P<0.05$); In the <4 years age group, facial expression, crying, leg movement, and total scores were significantly lower in the observation group ($P<0.05$), whereas consolability and activity scores showed no significant difference between the two groups ($P>0.05$) (**Figure 4**).

Comparison of incidence of postoperative complications between groups

In the observation group, one patient developed calcification, and two patients developed secondary infection, yielding an overall complication rate of 6%. In the control group, three patients developed calcification, six patients developed secondary infection, and two patients developed scalp necrosis, with a total

Table 2. Comparison of hematological and inflammatory indicators between the two groups [*M* (Q_1, Q_3)]

	Hb (g/dL)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	12.98 (12.68, 13.44)	11.11 (10.41, 11.45)*	12.09 (11.37, 12.60)*,#	167.227	<0.001
Control group (n = 52)	12.87 (12.47, 13.43)	9.88 (9.43, 10.40)*	10.89 (10.48, 11.45)*,#	423.414	<0.001
Z	-0.994	-6.865	-6.878		
P	0.320	<0.001	<0.001		
	PT (s)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	12.35 (11.73, 12.79)	12.29 (11.90, 12.56)	11.84 (11.36, 12.35)#	6.285	0.008
Control group (n = 52)	12.26 (11.60, 12.71)	13.89 (13.36, 14.42)*	11.99 (11.69, 12.57)#	163.658	<0.001
Z	-0.679	-8.702	-1.362		
P	0.497	<0.001	0.173		
	APTT (s)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	29.39 (27.50, 32.29)	32.35 (30.80, 33.78)*	29.51 (26.86, 32.59)	11.067	<0.001
Control group (n = 52)	30.96 (28.78, 33.82)	37.52 (35.42, 41.26)*	29.40 (27.22, 32.45)#	112.245	<0.001
Z	-1.724	-8.063	-0.054		
P	0.085	<0.001	0.957		
	Fib (g/L)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	3.08 (2.45, 3.64)	3.01 (2.56, 3.35)	2.94 (2.41, 3.70)	0.079	0.924
Control group (n = 52)	3.18 (2.61, 3.61)	2.43 (2.14, 2.74)*	3.22 (2.71, 3.60)#	33.989	<0.001
Z	-0.753	-5.399	-1.158		
P	0.451	<0.001	0.247		
	CRP (mg/L)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	5.32 (2.25, 7.16)	20.29 (15.26, 24.53)*	13.99 (11.76, 17.09)*,#	177.202	<0.001
Control group (n = 52)	5.00 (2.56, 7.73)	25.99 (20.72, 33.39)*	18.73 (13.55, 25.00)*,#	212.334	<0.001
Z	-0.435	-4.120	-4.043		
P	0.663	<0.001	<0.001		
	PCT (μg/L)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	0.23 (0.12, 0.37)	0.99 (0.74, 1.31)*	0.38 (0.28, 0.47)*,#	217.645	<0.001
Control group (n = 52)	0.29 (0.15, 0.42)	1.56 (1.30, 1.72)*	0.52 (0.40, 0.67)*,#	512.821	<0.001
Z	-1.192	-6.481	-5.086		
P	0.233	<0.001	<0.001		
	WBC ($\times 10^9$/L)			*F*	*P*
	Preoperative	24 h postoperative	72 h postoperative		
Observation group (n = 50)	6.87 (5.36, 8.53)	10.05 (9.16, 11.51)	7.86 (5.80, 8.78)	60.984	<0.001
Control group (n = 52)	7.93 (5.53, 9.02)	13.21 (12.22, 14.34)*	10.12 (9.02, 10.92)*,#	203.444	<0.001
Z	-1.011	-7.909	-7.267		
P	0.312	<0.001	<0.001		

Note: Hb: Hemoglobin, PT: Prothrombin Time, APTT: Activated Partial Thromboplastin Time, Fib: Fibrinogen, CRP: C-reactive protein, PCT: Procalcitonin, WBC: White Blood Cell Count. *Indicates a difference from preoperative comparisons, $P<0.05$. #Indicates a difference from 24 h postoperative comparisons, $P<0.05$.

complication rate of 21.15%. The complication rate in the observation group was significantly lower than that in the control group ($P<0.05$). Furthermore, six patients in the control group were readmitted postoperatively with a readmission rate of 11.54%, whereas no readmission occurred in the observation group ($P<0.05$) (**Table 4**).

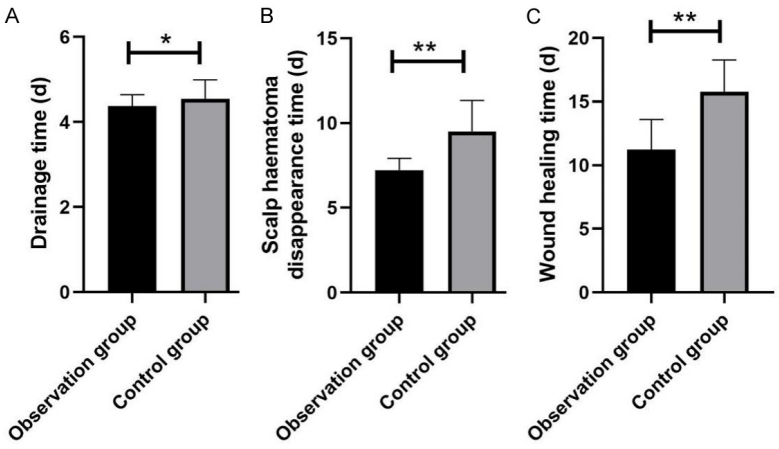

Figure 1. Comparison of postoperative rehabilitation indicators between the two groups. A. Drainage time; B. Hematoma resolution time; C. Wound healing time. Note: *P<0.05, **P<0.01.

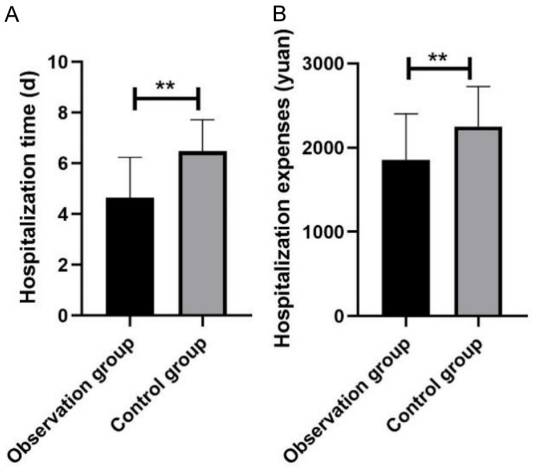

Figure 2. Comparison of hospitalization time (A) and expenses (B) between the two groups. Note: **P<0.01.

Comparison of quality of nursing care scores between groups

The observation group demonstrated significantly higher scores across all domains of nursing care quality assessment compared to the control group (condition mastery: (21.78 ± 1.90) vs. (19.53 ± 2.37); risk assessment: (20.88 ± 1.51) vs. (18.98 ± 2.03); drainage maintenance: (22.33 ± 1.43) vs. (21.53 ± 1.89); nurse-patient communication: (22.12 ± 2.09) vs. (18.56 ± 2.50)) (all P<0.05). The total score was (87.11 ± 3.00) in the observation group, significantly higher than (78.60 ± 4.65) in the control group (P<0.05) (**Figure 5A**, **5B**). Stratified by age, the highest scores was observed in the observation group with age <4 years (**Figure 5C**).

Nursing satisfaction

In the observation group, 32 caregivers reported being very satisfied, 17 satisfied, and 1 dissatisfied, resulting in an overall satisfaction rate of 98.00%. In the control group, 19 reported very satisfied, 23 reported satisfied, and 11 dissatisfied, with a satisfaction rate of 80.77%. Nursing satisfaction in the observation group was considerably higher than that in the control group (χ^2 = 9.009, P = 0.002) (**Table 5**).

Discussion

Modified negative-pressure drainage is currently the mainstay treatment for pediatric large scalp hematomas [3, 20]. However, due to the poor cooperation, immature organ systems, and underdeveloped immune function of pediatric patients, they are at higher risk for complications such as infection and tissue necrosis. Therefore, effective clinical treatment must be accompanied by high-quality nursing interventions to ensure safety and therapeutic efficacy [21, 22].

Recently, the standardized nursing process has been widely used in clinical settings. Its structured protocols and clearly defined procedures have been shown to enhance patient recovery and reduce adverse reactions and complications, making it a valuable framework for clinical nursing practice [11, 23-25]. In this study, a standardized nursing process was implemented in the perioperative care of children undergoing modified negative-pressure drainage for giant scalp hematoma. Results showed that the drainage duration, hematoma resolution time, and wound healing time of patients in the observation group were significantly shorter than those of the control group. In addition, the hospitalization time and associated costs were noticeably reduced. Subgroup analysis by age further supported the benefits of standardized nursing: in the <4 years group, the hematoma

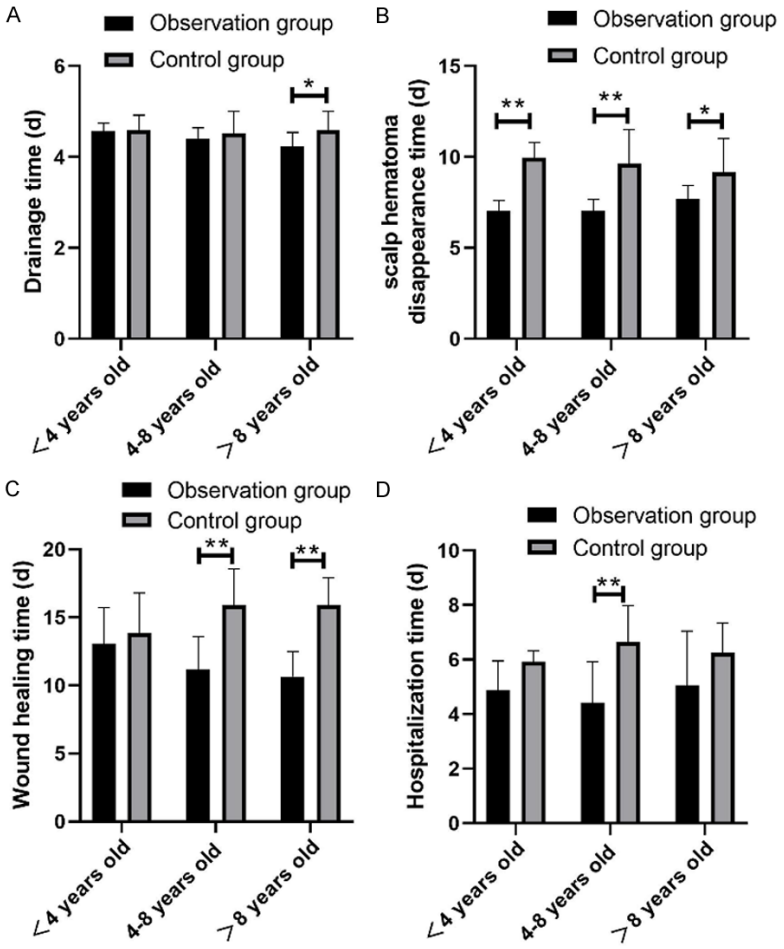

Figure 3. Comparison of rehabilitation indicators between the two groups of patients stratified by age. A. Drainage time; B. Hematoma resolution time; C. Wound healing time; D. Hospitalization time. Note: *P<0.05, **P<0.01.

resolution time in patients of the observation group was significantly shorter; in the 4-8 years group, the hematoma resolution time, wound healing time, and hospitalization time in the observation group were all significantly shorter; and in the >8 years group, the drainage duration, hematoma resolution time, and wound healing time were all markedly shorter in the observation group. These findings indicate that the standardized nursing interventions promote earlier recovery and reduce economic burden, consistent with previous reports [26, 27]. One possible reason is that the traditional nursing practices are passive, with care lagging behind the evolving condition, resulting in poor care outcomes [28]. In contrast, the standardized nursing intervention emphasizes proactive, stage-specific perioperative care tailored to the child's clinical status. Preoperatively, this includes comprehensive condition assessment, emotional support, and caregiver engagement to facilitate cooperation and ensure proper positioning for surgery [29]. Intraoperatively, continuous monitoring allows for early detection of abnormalities, enabling prompt medical intervention and targeted pain management to reduce agitation and crying, thereby supporting procedural success [30]. Postoperatively, focused care on drainage tube management and complication prevention further reduces adverse outcomes [31]. Collectively, these comprehensive and anticipatory nursing measures enhance the overall quality of care and accelerate patient recovery.

In this study, at 24 hours postoperatively, the observation group exhibited significantly higher levels of Hb and Fib compared to the control group. Conversely, the control group demonstrated higher levels of PT, APTT, CRP, PCT, and WBC, indicating pronounced differences in coagulation and inflammatory status between the groups during the early postoperative period. At 72 hours post-surgery, significant differences in Hb and other relevant indices persisted, while PT, APTT, and Fib levels exhibited a tendency towards convergence, suggesting ongoing disparity in systemic recovery. These findings imply that while coagulation function stabilized over time, differences in inflammatory status and hematologic data remained evident throughout early recovery. This pattern can be attributed to the implementation of a standardized nursing process [32]. The standardized nursing process adopted by the observation group effectively reduced the postoperative stress reaction of the children through systematic, comprehensive, and personalized nursing measures. Preoperatively, nursing staff provided comprehensive education regarding the disease and treatment plan, alongside psychological guid-

Table 3. Comparison of FLACC scores between the two groups before and after nursing interventions ($\bar{x} \pm s$)

Item		Observation group (n = 50)	Control group (n = 52)	*t*	*P*
Consolability	Pre-intervention	0.84 ± 0.22	0.82 ± 0.20	0.475	0.636
	Post-intervention	0.39 ± 0.07	0.77 ± 0.19	-13.347	<0.001
Facial expression	Pre-intervention	0.83 ± 0.21	0.81 ± 0.22	0.483	0.630
	Post-intervention	0.37 ± 0.09	0.72 ± 0.22	-10.481	<0.001
Crying	Pre-intervention	0.88 ± 0.20	0.86 ± 0.22	0.480	0.632
	Post-intervention	0.35 ± 0.05	0.82 ± 0.21	-15.586	<0.001
Leg movement	Pre-intervention	0.85 ± 0.20	0.83 ± 0.21	0.458	0.648
	Post-intervention	0.36 ± 0.08	0.78 ± 0.21	-13.217	<0.001
Activity	Pre-intervention	0.82 ± 0.23	0.84 ± 0.23	-0.457	0.649
	Post-intervention	0.35 ± 0.06	0.82 ± 0.23	-14.151	<0.001
Total score	Pre-intervention	4.22 ± 0.36	4.16 ± 0.46	0.714	0.477
	Post-intervention	1.82 ± 0.17	3.91 ± 0.51	-27.901	<0.001

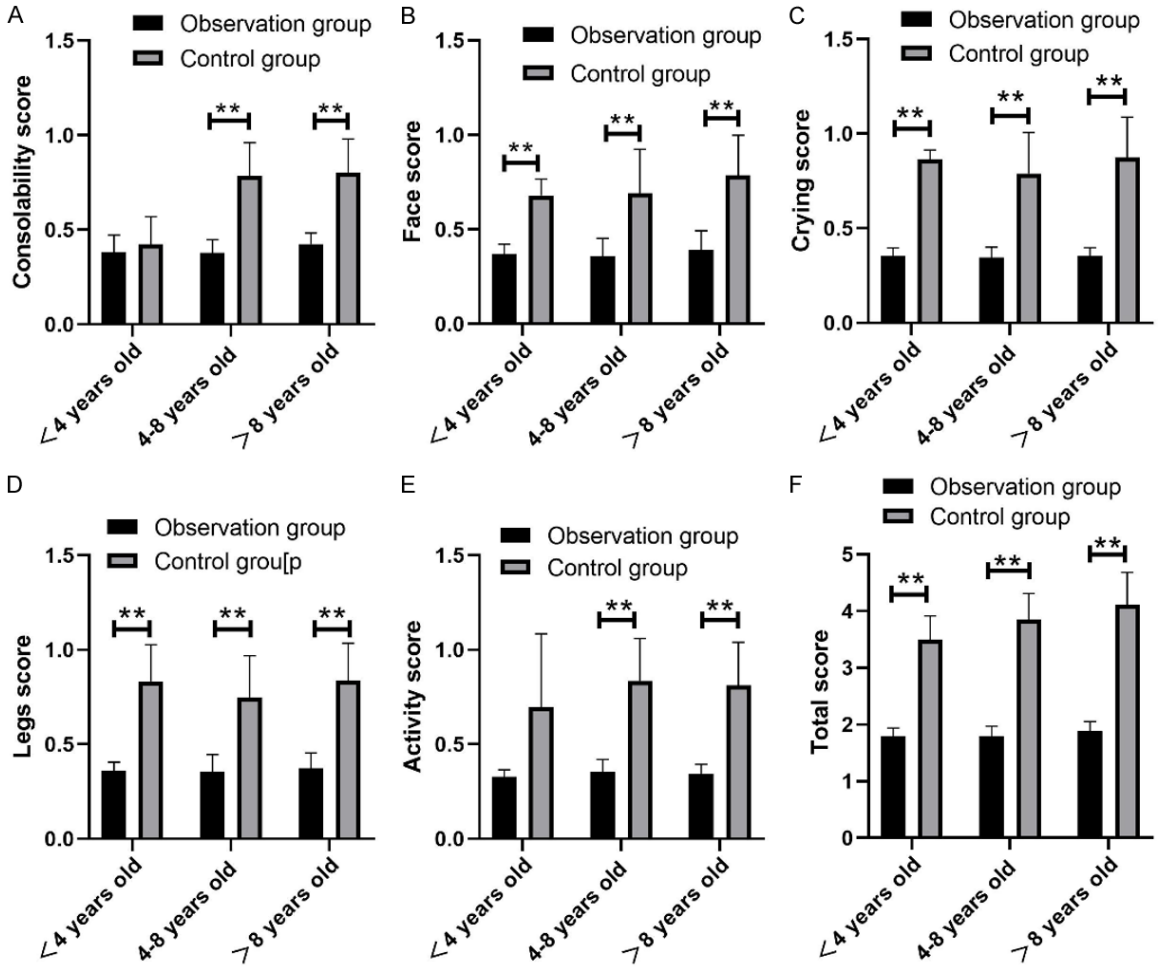

Figure 4. Comparison of pain scores between the two groups of patients stratified by age. A. Consolability scores; B. Facial expression scores; C. Crying scores; D. Leg movement scores; E. Activity scores; F. Total scores. ***P*<0.01.

ance to both children and their families. These interventions helped stabilize emotional and physiological status prior to surgery, reducing perioperative stress and enhancing surgical tol-

Table 4. Comparison of the incidence of postoperative complications between the two groups [n (%)]

Item	Observation group (n = 50)	Control group (n = 52)	χ^2	*P*
Calcification	1 (2.00)	3 (5.77)	-	-
Secondary infection	2 (4.00)	6 (11.54)	-	-
Scalp necrosis	0 (0)	2 (3.85)	-	-
Cephalic deformity	0 (0)	0 (0)	-	-
Total incidence	3 (6.00)	11 (21.15)	4.943	0.026
Readmission	0 (0)	6 (11.54)	6.130	0.013

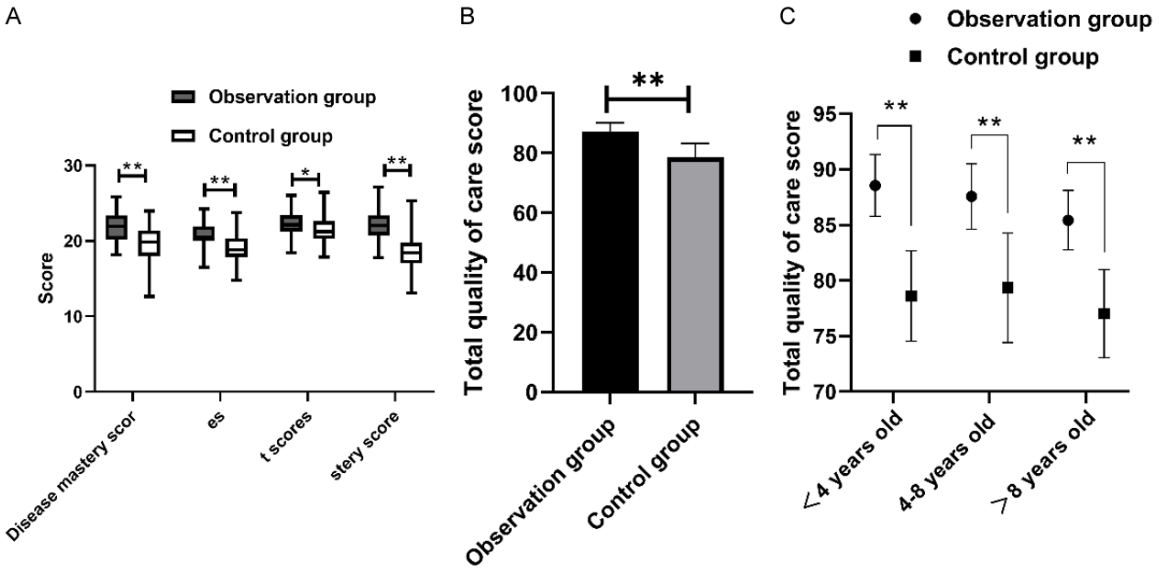

Figure 5. Comparison of quality of nursing care scores between the two groups. A. Comparison of individual quality of care scores between the two groups. B. Comparison of total quality of care scores between the two groups. C. Comparison of total quality of care scores between the two groups stratified by age. Note: *P<0.05, **P<0.01.

Table 5. Comparison of nursing satisfaction rate between the two groups [n (%)]

Item	Observation group (n = 50)	Control group (n = 52)	χ^2	*P*
Very satisfied	32 (64.00)	19 (36.54)	-	-
Satisfied	17 (34.00)	23 (44.23)	-	-
Dissatisfied	1 (2.00)	11 (21.15)	-	-
Total satisfaction	49 (98.00)	42 (80.77)	9.009	0.002

erance [33]. Postoperatively, patient conditions were closely monitored. For instance, hemoglobin levels were routinely monitored for 24 hours post-surgery. Upon identifying a decline in hemoglobin levels, prompt interventions, such as fluid resuscitation or transfusion, were initiated to support hemodynamic stability and Hb recovery. Additionally, the standardized nursing process attaches great importance to the dynamic monitoring of coagulation indexes. Abnormal coagulation indicators detected in the early postoperative phase prompted immediate, targeted interventions, including anticoagulant dose adjustments and supplementation of coagulation factors, facilitating a faster return to normal coagulation parameters by 72 hours. Concurrently, the meticulous wound management, adherence to strict aseptic surgical procedures, and rapid identification and treatment of infection-related indicators resulted in a significant decrease in inflammatory response, as evidenced by lower CRP, PCT, and WBC levels in the observation group within postoperative 72 hours. In summary, the imple-

mentation of standardized nursing process significantly improved postoperative physiologic outcomes in pediatric patients by reducing stress responses, promoting hemostatic recovery, and mitigating inflammation, thereby accelerating recovery and enhancing overall clinical outcomes.

The FLACC pain assessment demonstrated that post-intervention scores for consolability, facial expression, crying, leg movement, activity, and the total score were significantly lower in the observation group compared to the control group. This indicates that the standardized nursing process effectively alleviated postoperative pain. This improvement is likely attributable to the implementation of individualized pain care strategies developed according to each child's clinical condition. Age-stratified analysis further revealed that, in children aged 4-8 years and >8 years, the FLACC scores across all subscales and the total scores of the observation group were significantly lower than those of the control group. This may be explained by the enhanced cognitive, communicative, and pain-perception abilities of older children, allowing them to benefit more from structured nursing interventions and targeted pain management. In the <4 years age group, significant intergroup differences were observed in facial expression, crying, leg movement, and total scores. However, no significant differences were found in consolability and activity scores. This may have been because consolability in younger children is heavily influenced by parental involvement. The comfort provided by family members may have mitigated observable differences between routine and standardized nursing interventions in this domain [34]. In addition, due to limited mobility of younger children, particularly with regard to head movement, routine and standardized care processes were able to limit their movement through restraints, resulting in non-significant differences in activity scores.

The complication and readmission rates were considerably lower in the observation group compared to the control group, suggesting that the standardized nursing process effectively reduced postoperative complications. These results are similar to previous studies [11, 35]. Under conventional nursing models, postoperative drainage monitoring is often insufficient, possibly leading to delayed or incomplete drainage. Prolonged accumulation of blood in the affected area can contribute to calcification and sustained pressure on scalp tissue, which may lead to scalp necrosis [36, 37]. Additionally, inadequate monitoring of drainage fluid characteristics - such as changes in color or turbidity - may delay the detection of infection and thus increase the risk of secondary postoperative infections [38]. Standardized nursing emphasizes comprehensive postoperative management, particularly in drainage tube maintenance and complication prevention. Key interventions include routine inspection of drainage device functionality, monitoring the color and volume of drainage fluid, and scheduled repositioning of the patient to avoid drainage tube obstruction, tube dislodgment, and pressure ulcer formation. These measures collectively reduce the likelihood of adverse outcomes. The reduced readmission rate in the observation group was likely attributed to the comprehensiveness and effectiveness of the standardized care process. Conversely, the higher readmission rate in the control group may be explained by poorly controlled complications such as calcification and scalp necrosis, which often necessitate additional surgical procedures [39].

It has been reported that standardized nursing interventions can significantly improve the quality of care in pediatric patients [40, 41], consistent with the findings of this study. Results from the nursing quality assessment and nursing satisfaction survey demonstrated that the observation group scored significantly higher than the control group across all evaluated domains: disease mastery, risk assessment, drainage maintenance, nurse-patient communication, as well as in total care quality and overall nursing satisfaction. The results indicate that the standardized nursing process significantly improved the quality of nursing services. Specifically, comprehensive preoperative education for families improved disease mastery scores by enhancing caregiver understanding of the condition. Detailed preoperative history-taking and continuous perioperative monitoring contributed to higher risk assessment scores. Enhanced postoperative drainage care led to improved drain maintenance scores. Maintaining good communication with the patient's family throughout the perioperative period improved the nurse-patient communication score. Furthermore,

this study found that children in the observation group had notably higher total quality of care scores across all age groups than those in the control group. This suggests that standardized nursing procedures can improve the quality of care for children of all ages with huge scalp hematomas. The highest quality of care scores was found in children under four years of age. This is likely due to the greater reliance of younger children on family caregivers for treatment compliance and cooperation, making caregiver engagement a critical determinant of care quality in this group [42, 43]. In this study, the standardized nursing process effectively improved family compliance and reduced nursing resistance through psychological support and health education. Meanwhile, the incorporation of pain and comfort management minimized stress responses in children and ensured continuity of care, thereby further enhancing the overall quality of nursing.

This study demonstrated that the implementation of a standardized nursing intervention significantly promotes early recovery and improves the quality of care in children with giant scalp hematomas undergoing modified negative-pressure drainage. However, several limitations remain. For instance, the absence of long-term follow-up restricted the ability to assess the sustained efficacy of the intervention. Future studies should incorporate extended follow-up periods to evaluate long-term outcomes and identify prognostic risk factors associated with adverse recovery trajectories. Such investigations may facilitate the development of more targeted strategies to optimize long-term prognosis.

In summary, standardized nursing interventions have been shown to accelerate postoperative recovery, reduce the incidence of complications, and improve the quality of care and nursing satisfaction in children with massive scalp hematomas treated with modified negative-pressure drainage. These findings support the clinical value of this intervention and suggest wider use in pediatric surgical care.

Disclosure of conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Address correspondence to: Wei Song, Department of Neurosurgery, Children's Hospital Affiliated to The Capital Institute of Pediatrics, No. 2, Yabao Road, Chaoyang District, Beijing 100020, China. Tel: +86-18600721195; E-mail: huluhappy2011@163.com

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