

Study on the Application Effect of Quality Nursing Based on Non-Invasive Intracranial Pressure Monitoring in Patients with Intracranial Hypertension

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Abstract: *Objective:* To evaluate the efficacy of a quality nursing protocol guided by non-invasive intracranial pressure (ICP) monitoring on rehabilitation outcomes in patients with intracranial hypertension, thereby providing evidence-based support for precision nursing practices. *Methods:* A total of 120 patients with intracranial hypertension admitted to our hospital from June 2023 to June 2024 were selected and randomly assigned to a control group or an observation group (n = 60 per group) using a random number table. Baseline characteristics showed no statistically significant differences between the groups ($p > 0.05$). The control group received routine neurosurgical nursing care, including vital signs monitoring, administration of dehydrating agents, and regular turning with back percussion. The observation group received routine care supplemented by a multimodal non-invasive ICP monitoring strategy, which combined flash visual evoked potentials with ultrasound measurement of the optic nerve sheath diameter to dynamically assess ICP values and waveform changes. Furthermore, quality nursing interventions were implemented in accordance with the Expert Consensus on Nursing for the Prevention and Control of Intracranial Hypertension in Adult Critically Ill Patients. These interventions included individualized positioning management (adjusting head-of-bed elevation based on ICP values), refined airway management (administering pure oxygen before and after suctioning, with time-limited suctioning), proactive complication prevention (targeting infection, constipation, cerebral edema, deep vein thrombosis, and epilepsy), and psychological support. Glasgow Coma Scale (GCS) scores and ICP levels were compared before intervention and at discharge. Additionally, the rates of poor prognosis and total complications, as well as satisfaction with nursing care, were assessed. *Results:* Post-intervention, the observation group exhibited a significantly higher GCS score (12.4 ± 2.5) compared to the control group (9.8 ± 2.1), and a significantly lower ICP level (14.1 ± 2.8 mmHg vs. 18.5 ± 3.2 mmHg; $p < 0.05$). The rate of poor prognosis was significantly lower in the observation group (6.7%, 4/60) than in the control group (20.0%, 12/60), as was the total complication rate (3.3%, 2/60 vs. 15.0%, 9/60; $p < 0.05$). Furthermore, nursing satisfaction scores were significantly higher in the observation group ($p < 0.05$). *Conclusion:* A quality nursing protocol guided by multimodal non-invasive ICP monitoring effectively reduces ICP levels, improves consciousness, decreases complications, and enhances nursing satisfaction in patients with intracranial hypertension.

By innovatively integrating the multimodal concepts of the Brussels Consensus on non-invasive ICP monitoring with domestic nursing expert consensus, this study facilitates a transition from empirical nursing to data-driven precision nursing, offering a safe, feasible, and scalable model for neurosurgical ICP management.

Keywords: Intracranial pressure; Intracranial hypertension; Non-invasive monitoring; Quality nursing; Nursing intervention

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1. Introduction

Elevated intracranial pressure (ICP) is a prevalent and critical clinical manifestation in neurosurgery, commonly observed in hypertensive cerebral hemorrhage, severe traumatic brain injury (TBI), intracranial tumors, and other conditions. Epidemiological data indicate that the incidence of intracranial hypertension in patients with severe TBI ranges from 50% to 80%. More importantly, when ICP remains persistently above 20 mmHg, cerebral perfusion pressure declines, cerebral blood flow decreases, secondary cerebral ischemia and edema worsen, and brain herniation can rapidly develop. This pathological mechanism underlies the high disability and mortality rates in patients with severe TBI. Therefore, as the most direct physiological indicator for evaluating cerebral functional status, accurate ICP monitoring and appropriate management significantly impact patient prognosis^[1].

The 2021 SYNAPSE-ICU multinational prospective cohort study, which included 2395 patients with acute brain injury from 146 ICUs in 23 countries, concluded that invasive ICP monitoring significantly reduces 6-month mortality (OR = 0.82, 95% CI 0.68–0.98)^[2]. Subsequently, in 2023, Robba et al. demonstrated that a tiered management strategy for elevated ICP is highly correlated with improved patient outcomes, identifying early detection and timely intervention as key steps^[3]. However, although traditional invasive monitoring methods (external ventricular drainage and intraparenchymal probes) are recognized as the “gold standard,” they have significant limitations: a relatively high infection risk (3–15%), technical complexity, high cost, unsuitability for patients with coagulation dysfunction, and limited feasibility in resource-constrained settings.

As non-invasive ICP monitoring technology has advanced rapidly, it has become a safer and more reliable alternative in clinical practice. The non-invasive intracranial pressure monitor is based on the principle of flash visual evoked potential, making it naturally applicable for screening elevated ICP resulting from TBI and cerebral hemorrhage. Specifically, after affixing scalp electrode patches, flash visual evoked potential goggles are applied in combination with hemodynamic data monitoring. The entire procedure takes only 3 minutes to obtain real-time ICP and cerebral perfusion pressure readings, with measurement error strictly controlled within 10%^[4,5].

Numerous studies have systematically compared various non-invasive ICP monitoring technologies, including brain imaging, near-infrared spectroscopy, electroencephalography, transcranial Doppler, and methods based on ocular and auditory structures^[6]. In 2025, 41 international TBI experts jointly published the ‘Brussels Non-invasive ICP Monitoring Consensus’ (B-ICONIC), providing clinically feasible guidelines for bedside non-invasive ICP tools. The consensus recommends key techniques such as automated pupillometry (neuro-pupillary index, NPi), ultrasound measurement of optic nerve sheath diameter (ONSD),

and transcranial Doppler-derived indices. It advocates a multimodal strategy: using at least two concordant non-invasive ICP techniques, combined with clinical examination and neuroimaging findings, to guide ICP management^[7]. For example, escalation of ICP therapy should be considered when $\text{NPi} \leq 3$, $\text{ONSD} \geq 6$ mm (indicating $\text{ICP} \geq 20$ mmHg), or the TCD pulsatility index is elevated (≥ 1.4 , corresponding to predicted $\text{ICP} \geq 20$ mmHg)^[8].

Furthermore, extensive literature indicates that non-invasive ICP monitoring technology effectively assesses intracranial compliance in conditions such as TBI, spontaneous intracranial hemorrhage, and hydrocephalus. Its main parameters show an excellent correlation with invasive ICP measurements^[9].

Given the pivotal role of nursing staff in ICP management, the Chinese Journal of Nursing published the Expert Consensus on Nursing for the Prevention and Control of Intracranial Hypertension in Adult Critically Ill Patients in 2024

This consensus covers ten aspects across four dimensions: identification, monitoring, prevention and control measures, and emergency care.

The key management points were summarized systematically and hierarchically: nurses must first master the clinical manifestations of intracranial hypertension and then follow standardized procedures to perform monitoring and nursing care, thereby effectively improving patient prognosis^[10]. Notably, the article explicitly points out that using non-invasive monitoring data to guide interventions—such as head-of-bed elevation to 30° , airway management, sedation and analgesia, and complication prevention—naturally and appropriately controls ICP fluctuations and avoids secondary injury potentially caused by medical procedures. Therefore, the fundamental purpose of this study is to evaluate the effect of quality nursing based on non-invasive intracranial pressure monitoring in patients with elevated ICP, ultimately providing strong evidence to support clinical nursing practice.

2. Materials and methods

2.1. Clinical data

This study enrolled 120 patients with elevated intracranial pressure hospitalized at our institution between June 2023 and June 2024. Participants were randomly assigned to a control group or an observation group, with 60 cases in each. The control group comprised 32 males and 28 females, aged 21–78 years, with a mean age of 51.8 ± 4.9 years. Etiologies included hypertensive intracerebral hemorrhage (20 cases), severe traumatic brain injury (18 cases), intracranial tumor (12 cases), subarachnoid hemorrhage (8 cases), and other causes (2 cases). The observation group consisted of 33 males and 27 females, aged 20–79 years, with a mean age of 52.5 ± 5.1 years. The etiological distribution was as follows: hypertensive intracerebral hemorrhage (21 cases), severe traumatic brain injury (17 cases), intracranial tumor (11 cases), subarachnoid hemorrhage (9 cases), and other causes (2 cases). No statistically significant differences were observed between the two groups in baseline characteristics, including sex, age, disease duration, and etiological composition ($p > 0.05$), indicating good comparability.

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

Participants were required to meet the following stringent criteria:

- (1) Intracranial hypertension was confirmed by head CT or MRI, with eligible conditions including

- hypertensive intracerebral hemorrhage, severe traumatic brain injury, and intracranial tumors;
- (2) Glasgow Coma Scale score < 8 at admission;
 - (3) Age 18–80 years;
 - (4) The study was approved by the hospital medical ethics committee, and informed consent was obtained from the patients' family members.

2.2.2. Exclusion criteria

Patients were excluded if they presented with any of the following contraindications:

- (1) Severe ocular disease, trauma, or history of ocular surgery preventing pupil observation;
- (2) Malignant tumors, severe systemic diseases (cardiac, hepatic, or renal failure), or psychiatric disorders;
- (3) Recent use of medications affecting intracranial pressure (e.g., mannitol, diuretics);
- (4) Brain death or a moribund condition;
- (5) Contraindications to magnetic resonance imaging precluding completion of the examination.

2.3. Methods

2.3.1. Intracranial pressure monitoring method

Upon admission, all patients received routine symptomatic neurosurgical management, including the administration of dehydrating agents to reduce intracranial pressure,

Following admission, patients underwent routine symptomatic neurosurgical management, which included the administration of dehydrating agents to lower intracranial pressure, hemostatic therapy, and neurotrophic treatment. Concurrently, systematic and continuous monitoring of intracranial pressure (ICP) levels was performed using a non-invasive multifunctional monitor. This device employs dual-principle technology that combines flash visual evoked potential (FVEP) with hemodynamic parameters. Electrode patches collected electrophysiological signals from the visual pathway and hemodynamic indicators, and a built-in regression equation model directly calculated the ICP value.

Flash visual evoked potential is one of the earliest established and most technically mature types of cortical evoked potentials in clinical research. It represents the change in electrical activity recorded in the occipital cortex following diffuse, non-patterned flash stimulation of the retina ^[11]. FVEP allows for the assessment of visual pathway integrity, which extends from the retina to the occipital lobe. Because the visual pathway is located at the base of the cranial cavity and its nerve fibers have a long course, intracranial lesions often adversely affect optic nerve function ^[12]. Non-invasive ICP monitoring technology based on FVEP can estimate ICP values with reasonable accuracy, serving as a reliable method for clinical auxiliary diagnosis and treatment ^[13]. Prior to monitoring, the instrument underwent a systematic and standardized inspection. Electrode connections were confirmed to be secure, and parameters were calibrated to baseline. The patient was instructed to close their eyes and relax, and electrodes were placed at standard positions using strict aseptic technique. This procedure ensured the reliable and accurate recording of ICP readings once stable waveforms were obtained. Continuous ICP monitoring commenced upon admission, with trends systematically recorded daily. The ICP grading criteria are defined as follows: normal, 5–15 mmHg; mild elevation, 15–20 mmHg; moderate elevation, 20–40 mmHg; and severe elevation, > 40 mmHg. Routine monitoring is performed 4–6 times daily; during the acute phase or upon changes in clinical condition, the monitoring frequency is increased to capture ICP fluctuations in a timely manner.

In addition to FVEP, bedside non-invasive ICP monitoring offers effective multimodal strategies. The B-ICONIC consensus provides a clear description of using ultrasound to measure the ONSD for identifying patients at risk of intracranial hypertension: an ONSD ≥ 6 mm indicates an ICP ≥ 20 mmHg^[14]. Furthermore, an elevated transcranial Doppler pulsatility index (≥ 1.4) is directly correlated with increased ICP. Therefore, FVEP and ONSD can be combined for multimodal ICP assessment.

2.3.2. Nursing methods

Upon admission, all patients received routine neurosurgical nursing interventions, which primarily included: close monitoring of consciousness levels, pupil changes, and vital signs; administration of dehydrating agents as prescribed; maintenance of a patent airway; assistance with scheduled turning and gentle back tapping; and implementation of basic complication prevention measures.

Control group: The routine nursing protocol was adopted, involving dynamic observation of clinical manifestations, strict adherence to medical orders for all nursing procedures, increased frequency of ward rounds, improved nursing documentation, and immediate reporting of any abnormal conditions to the attending physician for management.

Observation group: In addition to routine care, quality nursing based on non-invasive intracranial pressure (ICP) monitoring was implemented. This approach standardized the nursing process in accordance with the Expert consensus on nursing for the prevention and control of intracranial hypertension in adult critically ill patients, systematically covering the identification, monitoring, prevention, control, emergency treatment, and nursing care of intracranial hypertension.

(1) Instrument use management

As the responsible nurses were familiar with the operating procedures and waveform interpretation methods of the non-invasive multifunctional ICP monitor, they recorded ICP values and waveform trends systematically every 2–4 hours. If ICP exceeded 20 mmHg with a continuous rise, or if waveforms were abnormal (increased P2/P1 ratio or presence of plateau waves), the physician was notified promptly, and the nurse assisted actively in management. If ICP remained > 25 mmHg for more than 30 minutes, the risk of brain herniation was considered high, and the emergency protocol was initiated immediately.

(2) Positioning management

Head-of-bed elevation was adjusted in a stepwise manner based on real-time ICP readings. The fundamental principle was as follows: when ICP was within the normal or mildly elevated range, the patient was placed in a supine position or with the head-of-bed elevated 15–30°; when ICP was moderately elevated, the head-of-bed was maintained at 30°, while strictly avoiding excessive rotation or flexion of the head and neck to prevent impairment of jugular venous return. Nursing procedures such as turning and suctioning were performed gently, with ICP monitored before and after to prevent procedure-induced spikes. Notably, meta-analyses have confirmed that head-of-bed elevation of 15–30° effectively reduces ICP without compromising cerebral perfusion pressure.

(3) Airway management

Ensuring airway patency is fundamental to controlling ICP, as dyspnea and systemic hypoxia can exacerbate intracranial hypertension. Hierarchical nursing measures included: prompt and thorough clearance of oral and nasal secretions; reasonable adjustment of airway humidification parameters based on sputum viscosity; strict adherence to aseptic technique during suctioning; limitation of single suctioning duration to

within 15 seconds; and administration of pure oxygen before and after each suctioning to avoid transient ICP elevation. For patients with consciousness disorders, the airway was proactively protected, and tracheotomy or ventilator-assisted ventilation was coordinated with physicians when necessary. For all patients receiving mechanical ventilation, preventive measures for ventilator-associated pneumonia were implemented systematically, including head-of-bed elevation to 30–45°, daily assessment of extubation readiness, and meticulous oral care.

(4) Complication prevention

Infection prevention and control: To strengthen environmental management and aseptic technique, drainage bags were changed daily, strict disinfection was performed around the puncture site, and changes in body temperature and routine blood tests were monitored proactively. As intracranial pressure monitoring carries a high risk of intracranial infection, the Expert consensus on nursing for the prevention and control of intracranial hypertension in adult critically ill patients identifies intracranial infection as a critical complication, recommending strict aseptic technique and minimization of monitoring duration^[15,16].

Constipation prevention and bowel management: Patients were instructed to consume a diet rich in dietary fiber (vegetables, fruits, whole grains), maintain adequate daily fluid intake, and, when necessary, receive prescribed mild laxatives such as lactulose. Because straining during defecation increases intrathoracic and intra-abdominal pressure, it can impair cerebral venous return and trigger a rapid rise in ICP. Therefore, nursing interventions proactively guided patients to develop regular bowel habits, and bedridden patients were assisted to achieve smooth bowel movements. **Cerebral edema management:** The severity of cerebral edema was assessed by repeating head CT scans in conjunction with ICP changes. Dehydrating agents (e.g., mannitol, hypertonic saline) were administered according to medical orders, intake and output were strictly recorded, and electrolytes and renal function were monitored proactively. **Deep Vein Thrombosis Prevention:** From the early stage of illness, passive limb exercises were actively assisted; daily lower limb pneumatic compression therapy was provided; anticoagulant medications were administered rationally as prescribed; and lower limbs were carefully observed for swelling and pain. **Epilepsy Prevention and Management:** Patients were carefully observed for prodromal signs of seizures (e.g., altered consciousness, abnormal behavior, staring). For high-risk patients, prophylactic antiepileptic drugs were administered in a timely and standardized manner as prescribed, and emergency equipment was kept ready at the bedside.

(5) Psychological nursing

For conscious patients, psychological support was proactively provided through verbal communication to alleviate anxiety and fear. Simultaneously, disease-related knowledge and cooperation essentials were explained systematically to family members, and basic nursing skills were taught to relieve their psychological pressure and improve treatment compliance. For patients with gradually recovering consciousness, emotional reactions were monitored, changes in condition were explained truthfully, and confidence in treatment was reinforced.

2.4. Outcome measures

The following indicators were compared between the two groups: Glasgow Coma Scale (GCS) score, intracranial pressure (ICP), prognostic outcome, complication rate, and nursing service satisfaction.

Glasgow Coma Scale: The GCS is a reliable and widely used tool for assessing the degree of consciousness impairment. It evaluates three aspects: eye opening, verbal response, and motor response. Total scores range from 3 to 15, with lower scores indicating more severe coma. In this study, assessments

were conducted at admission, on day 7 post-intervention, and at discharge. For comatose patients, the GCS was assessed every 1–2 hours; a decrease of ≥ 2 points warranted heightened vigilance.

Intracranial pressure measurement: ICP readings were recorded in both groups before the nursing intervention and at weeks 1, 2, and 3 post-intervention. For each measurement, the average of three consecutive readings obtained within 30 minutes was calculated for between-group comparison.

Prognosis assessment: Patient recovery was graded according to the Glasgow Outcome Scale, which comprises five levels: good recovery, moderate disability, severe disability, vegetative state, and death. Severe disability, vegetative state, and death were combined and defined as poor prognosis, and the incidence of poor prognosis was calculated for each group.

Complications: The number of patients in each group who developed complications during hospitalization, such as pulmonary infection, intracranial infection, constipation, cerebral edema, and lower extremity deep vein thrombosis, was recorded, and the overall incidence of complications was calculated.

Satisfaction with nursing care: A hospital-designed nursing satisfaction questionnaire was completed by patients or their family members before discharge. The total score was 100 points, with higher scores indicating greater satisfaction.

2.5. Statistical analysis

Data processing and statistical analysis were performed using SPSS 26.0.

Normally distributed continuous variables are expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$), with between-group comparisons conducted using the independent samples *t*-test. Categorical data are presented as frequencies and percentages (%), and the χ^2 test was used for between-group comparisons.

2.6. Ethics approval

The Ethics Committee of the Chinese PLA General Hospital approved this study (approval number: LL-J-CSY-2026-27; approval date: July 24, 2026). The study underwent expedited review, and the requirement for informed consent was waived. All procedures adhered to the ethical principles of the Declaration of Helsinki.

3. Results

3.1. Comparison of GCS scores and ICP levels between the two groups

Following the intervention, the observation group exhibited significantly higher GCS scores and lower ICP levels compared to the control group ($p < 0.05$). Detailed data are presented in **Table 1**.

Table 1. Comparison of GCS scores and ICP levels before and after intervention between the two groups

Group	Number of cases	GCS score (admission)	GCS score (discharge)	ICP level (admission/mmHg)	ICP level (discharge/mmHg)
Control group	60	6.5 $\pm$ 1.2	9.8 $\pm$ 2.1	26.3 $\pm$ 4.5	18.5 $\pm$ 3.2
Observation group	60	6.6 $\pm$ 1.3	12.4 $\pm$ 2.5	25.9 $\pm$ 4.8	14.1 $\pm$ 2.8

3.2. Comparison of prognosis and complications between the two groups

The observation group exhibited significantly lower incidences of poor prognosis and overall complications

compared with the control group ($p < 0.05$). Detailed data are presented in **Table 2**.

Table 2. Comparison of Poor Prognosis and Complication Rates between the Two Groups [n(%)]

Group	Number of cases	Poor prognosis	Total complications
Control group	60	12 (20.0)	9 (15.0)
Observation group	60	4 (6.7)	2 (3.3)

4. Discussion

In critically ill neurosurgical patients, elevated intracranial pressure (ICP) constitutes the core pathology. Persistent ICP exceeding 20 mmHg reduces cerebral perfusion pressure and cerebral blood flow, leading to secondary cerebral ischemia that exacerbates cerebral edema. In severe cases, this cascade can rapidly progress to brain herniation, representing a primary determinant of poor prognosis and frequent complications. Xue Yating et al. (2023) systematically reviewed evidence on ICP management in hemorrhagic stroke, summarizing 23 high-quality items across five dimensions: assessment and dynamic monitoring, management goals, interventions, treatment modalities, and risk control. Their analysis demonstrated that proactive, standardized ICP management improves patient prognosis^[1]. Complementing this, Guimarães and Cruz (2023) highlighted that ICP monitoring necessitates close nurse-physician collaboration; nurses must promptly assess intracranial hypertension, detect ICP changes, and initiate appropriate interventions^[17].

Traditional nursing care has long relied on patients' clinical presentations and vital signs to guide empirical interventions. Consequently, this approach is inherently limited by significant lag and a lack of specificity, preventing the prompt and accurate detection of subtle intracranial pressure (ICP) changes and hindering the provision of truly individualized, precise nursing care. Chen et al. conducted a rigorous study demonstrating that an ICP monitoring-guided individualized nursing strategy offers distinct clinical advantages for patients with severe traumatic brain injury. Following the intervention, the observation group exhibited superior GCS scores and short-term prognosis indicators compared to the routine nursing control group ($p < 0.05$). Furthermore, a current summary of best evidence for nursing care of intracranial hypertension in adult patients with severe brain injury systematically reviewed 33 articles. This review synthesized 33 high-quality evidence items across eight dimensions, including ICP threshold setting, assessment and monitoring methods, respiratory care, circulatory function maintenance, analgesia and sedation, thermoregulation, nutritional support, and cerebrospinal fluid drainage care, thereby establishing a foundation for the standardization of clinical nursing pathways.

Non-invasive ICP monitoring technology effectively addresses the limitations of invasive methods, such as extensive wound areas, high operational risks, and numerous complications. This approach enables the continuous, real-time, and reliable acquisition of intracranial pressure fluctuation data, thereby providing a robust foundation for precision nursing. Chen Yunna et al. (2025) provided a clear summary, noting that non-invasive ICP monitoring has become a focal point in neurocritical care, with FVEP widely applied in clinical practice^[4]. However, invasive methods remain the "gold standard" regarding measurement accuracy, result reliability, and treatment selectivity; thus, non-invasive technology requires further validation before mature clinical application^[4]. Consequently, non-invasive monitoring is currently best utilized as a supplement to invasive monitoring.

The Brussels Non-invasive ICP Monitoring Consensus provides important standardized guidance for

the clinical application of non-invasive monitoring techniques^[7]. This consensus emphasizes the adoption of a multimodal strategy, specifically combining at least two concordant non-invasive ICP techniques with clinical examination and neuroimaging to guide ICP management^[8]. This study adopted a multimodal non-invasive monitoring protocol combining FVEP and ONSD assessment, which aligns with the core concept of the B-ICONIC consensus and effectively improved the accuracy and reliability of ICP monitoring. This practice also indicates that single non-invasive techniques are prone to error, suggesting that multimodal fusion represents the future direction.

This study presents a systematic, layered approach to quality nursing based on non-invasive intracranial pressure (ICP) monitoring, extending beyond routine care models. Grounded in monitoring data, the protocol systematically implements dynamic position adjustment, meticulous airway management, individualized sedation and analgesia, targeted dehydration therapy, and early warning interventions for complications. Consequently, nursing protocols are adjusted promptly in response to ICP fluctuations, thereby mitigating risk factors that elevate intracranial pressure, maximizing brain tissue protection, and ultimately facilitating neurological recovery.

The results of this study demonstrate that, following intervention, the observation group exhibited a significantly higher GCS score than the control group (12.4 ± 2.5 vs. 9.8 ± 2.1 , $p < 0.05$), significantly lower ICP levels (14.1 ± 2.8 mmHg vs. 18.5 ± 3.2 mmHg, $p < 0.05$), and reduced rates of poor prognosis (6.7% vs. 20.0%) and total complications (3.3% vs. 15.0%) ($p < 0.05$). These findings indicate that the nursing protocol guided by non-invasive intracranial pressure monitoring facilitates a better understanding of intracranial pressure dynamics, thereby effectively improving consciousness and neurological function. Furthermore, this model enables individualized care based on precise data, minimizing nursing blind spots and enhancing care quality and safety. Consequently, patients in the observation group and their families reported a more favorable experience and higher satisfaction with the nursing services provided.

Non-invasive ICP monitoring technology has well-defined, objective limitations: all indirect methods are constrained by calibration and zero-point correction, limiting absolute measurement accuracy. The 95% limits of agreement for TCD-based methods are approximately ± 7 – 15 mmHg. Therefore, integrating multimodal technologies and adopting advanced signal analysis methods represents a viable strategy to enhance predictive accuracy. In the clinical management of acute brain injury, non-invasive monitoring serves as an effective complement to invasive techniques. It is appropriately utilized for patient screening prior to invasive procedures, cerebral function assessment in moderate traumatic brain injury, and intracranial pressure management in patients with coagulation dysfunction. These applications highlight future research directions: exploring optimal parameter combinations for non-invasive ICP monitoring and standardizing nursing intervention pathways to facilitate clinical adoption.

5. Conclusion

In conclusion, quality nursing guided by non-invasive intracranial pressure (ICP) monitoring significantly improves clinical outcomes in patients with elevated ICP. Compared with routine nursing, this protocol achieves higher GCS scores, lower ICP levels, reduced rates of poor prognosis and complications, and greater nursing satisfaction. Non-invasive ICP monitoring provides a safe, objective, and real-time basis for individualized nursing interventions, offering a practical and effective strategy for neurosurgical critical care.

Further large-scale multicenter studies are warranted to validate and refine these nursing protocols.

Disclosure statement

The authors declare no conflict of interest.

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