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Nursing Care of a Patient with Intracranial Aneurysm Rupture and Hemorrhage Complicated by Pulmonary Embolism After Surgery

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Abstract: *Objective*: To summarize the nursing experience of a patient with intracranial aneurysm rupture and hemorrhage who developed pulmonary embolism after clipping surgery. *Methods*: A patient in our hospital, who had intracranial aneurysm rupture and hemorrhage and developed pulmonary embolism after clipping surgery, was selected as the research subject. Through multidisciplinary collaboration, standardized assessment and dynamic condition observation, various risks were identified early. Combined with the patient's individual characteristics, a personalized nursing plan was formulated. During the treatment process, emphasis was placed on strengthening the patient's airway management, closely monitoring various indicators, and preventing postoperative complications. Targeted nursing measures were adopted: reasonable airway humidification and effective lung care were used to gradually control the patient's pulmonary infection; fluid balance management and individualized care were implemented to ensure the patient's normal circulating blood volume, thereby optimizing cerebral perfusion and cerebral oxygenation. Since the patient had overlapping risk factors for bleeding and thromboembolic events, evidence-based nursing principles were followed for thromboembolism prevention, and anticoagulation strategies and nursing plans were dynamically adjusted to reduce the occurrence of postoperative complications. *Results*: The patient's condition improved and was successfully discharged on the 22nd day after surgery, and then transferred to a local rehabilitation hospital for further treatment. At the 1-month follow-up after discharge, the patient recovered well; at the 3-month follow-up after discharge, the patient had recovered and returned home. *Conclusion*: The results show that standardized assessment and condition observation, multidisciplinary collaboration, and personalized nursing plans can significantly reduce the occurrence of postoperative complications and improve the patient's prognosis. This nursing experience provides a reference for the nursing of similar patients in the future.

Keywords: Intermuscular venous thrombosis; Intracranial aneurysm; Nursing care; Pulmonary embolism

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1. Introduction

Intracranial aneurysm (IA) refers to a localized, pathological dilatation of the intracranial arterial wall that forms an aneurysmal protrusion [1]. It is the leading cause of subarachnoid hemorrhage, and surgical treatment is generally the primary approach. Among postoperative complications of IA, deep venous thrombosis (DVT) is common, with an incidence rate of up to 9.7%; the incidence of asymptomatic thrombosis can be as high as 24%, and calf muscle venous thrombosis (CMVT) is the most frequent type [2]. 80–90% of emboli in acute pulmonary embolism (APE) originate from the detachment and migration of lower extremity DVT [3]. Mild cases present with symptoms such as dyspnea, chest pain, hemoptysis, and fever, while severe cases may lead to cyanosis, shock, or even death. Early researchers believed that CMVT, which does not involve the main veins of the lower extremities, could dissolve or organize on its own without causing corresponding complications, so it has long been overlooked.

However, with the in-depth research on CMVT by scholars worldwide, there have been an increasing number of literature reports indicating that APE can be directly caused by CMVT, or by CMVT extending to cause main DVT in the thigh and then leading to APE [4]. Nevertheless, there are currently few studies on distal DVT, especially CMVT. There is significant controversy regarding the frequency and severity of CMVT complicated with APE, resulting in inconsistent treatment decisions made by clinicians when facing CMVT [4]. Meanwhile, nurses have insufficient understanding of CMVT and lack relevant nursing experience.

On 26 May 2024, our hospital admitted a patient with calf muscle venous thrombosis complicated by pulmonary embolism after surgery for ruptured intracranial aneurysm. After 22 days of multidisciplinary treatment and meticulous nursing care, the patient's condition stabilized and was transferred to a local rehabilitation hospital for further treatment. The nursing experience is reported as follows.

2. Clinical data

2.1. General information

A 70-year-old female patient was admitted to the emergency department on 26 May 2024, due to "sudden headache with unconsciousness for more than 1 hour". She was in deep coma, with a Glasgow Coma Scale (GCS) score of 3T (E1VTM2). There was redness and swelling in the right temporal and parietal regions, without obvious subcutaneous pulsation. Both pupils were equal in size and round, with a diameter of approximately 3 mm, and the light reflex was dull. The bilateral nasolabial folds were symmetrical, and the corner of the mouth was centered. The muscle strength of the left limb was grade 0, and that of the right limb was approximately grade 1. The muscle tone of all limbs was normal, physiological reflexes were present, and pathological reflexes could not be elicited.

Cranial computed tomography angiography (CTA) combined with chest CT showed an irregular aneurysm at the M1 bifurcation of the right middle cerebral artery; right temporal lobe cerebral hemorrhage, subarachnoid hemorrhage, blood accumulation in the lateral ventricles and third and fourth ventricles, and mild ventricular dilatation; bilateral lower lung dependent inflammation. The patient was admitted to the hospital with a provisional diagnosis of "(right) middle cerebral artery aneurysm rupture complicated with subarachnoid hemorrhage".

She had a history of uterine fibroid resection and blood transfusion. Her recent diet and sleep were normal, bowel and bladder functions were regular, and there was no significant change in body weight.

2.2. Treatment course and outcome

After admission, the patient was immediately placed in the emergency surgical green channel and underwent

general anesthesia for IA clipping, hematoma evacuation, decompressive craniectomy, third ventriculostomy, and aneurysm wrapping. The intraoperative blood loss was 490 ml, and she was transferred to the intensive care unit (ICU) for further treatment after surgery.

On the 8th postoperative day, the patient's condition was stable and she was transferred to the neurosurgery ward. Physical examination on admission to the ward showed coma, with a GCS score of 4T (E1VTM3). Both pupils were equal in size and round, with a diameter of approximately 2.0 mm, and the light reflex was dull. Vital signs were as follows: body temperature 37.6℃, heart rate 94 beats/min, respiratory rate 26 breaths/min, blood pressure 154/104 mmHg, and pulse oxygen saturation 99%. A size 7.5 tracheal cannula was in place, and sputum culture indicated *Acinetobacter baumannii* infection.

The nurse assisted the doctor in placing a lumbar cistern drainage tube at the bedside, and bloody turbid cerebrospinal fluid (CSF) was drained. The CSF pressure fluctuated between 100–105 mmH_2O. Treatment included anticoagulation, correction of electrolyte imbalance, combined intravenous and enteral nutritional support, and anti-infection therapy as prescribed by the doctor.

On the 10th postoperative day, re-examination of cranial and chest CT showed absorption of intracranial hemorrhage compared with the previous scan, and progression of bilateral lung inflammation. Lower extremity color Doppler ultrasound revealed local calf muscle venous thrombosis. The patient was given enoxaparin sodium 2000 units once daily (QD) combined with batroxobin 5 BU every other day (QOD) for anticoagulation, and 100 ml warm water via nasogastric tube every 8 hours (Q8h). A consultation with the rehabilitation department was requested, and early bedside rehabilitation was provided.

On the 12th postoperative day, the patient's respiratory rate was 35–40 breaths/min. Pulmonary artery CTA showed local branch embolism in the right middle and lower lobes of the lung, and suspected local branch embolism in the left lower lobe. A consultation with the respiratory department was requested. Emergency blood tests showed: fibrinogen 1.48 g/L, D-dimer 24.26 mg/L, sodium 155 mmol/L, and chlorine 126 mmol/L. Blood gas analysis showed: arterial partial pressure of oxygen 56.4 mmHg, partial pressure of carbon dioxide 46.7 mmHg (normal range 35–45 mmHg). The treatment was adjusted to enoxaparin sodium 4000 units QD, and 100 ml warm water via nasogastric tube every 4 hours (Q4h).

On the 16th postoperative day, re-examination of cranial and chest CT showed absorption of intracranial effusion and hemorrhage compared with the previous scan, absorption of bilateral lung inflammation, and improvement of all laboratory indicators. The lumbar cistern drainage tube was removed as prescribed by the doctor, and intravenous infusion of batroxobin injection was suspended. On the 22nd postoperative day, the patient was discharged from the hospital and transferred to a rehabilitation hospital for continued treatment.

3. Nursing care

3.1 Standardized and accurate assessment, dynamic condition observation, and early identification of various risks

Postoperative rebleeding is a key factor affecting the prognosis of aneurysmal subarachnoid hemorrhage. Studies have shown that approximately 13.6% of patients experience rebleeding [1,2]. Therefore, the following measures were implemented for this patient:

(1) Various assessment scales, including the Barthel Index, Braden Scale, Caprini Risk Assessment Model, Morse Fall Scale, NRS 2002 Nutritional Risk Screening Scale, and Glasgow Coma Scale (GCS), were

used for standardized and accurate assessment to identify various risks at an early stage;

(2) Continuous 24-hour electrocardiographic monitoring was provided to dynamically track the patient's heart rate, electrocardiogram, blood oxygen saturation, chest movement, as well as laboratory indicators and imaging findings;

(3) Responsibility-based holistic nursing was implemented to ensure a coordinated emergency response between medical and nursing staff. First-aid equipment such as a simple manual resuscitator and defibrillator was prepared at the bedside. In case of changes in the patient's condition, the doctor was promptly notified for appropriate treatment, and a joint emergency nursing protocol for acute pulmonary embolism was developed;

(4) By consulting experts and reviewing literature, combined with the patient's specific condition, the most common and severe postoperative complications of this patient were identified. The priorities and difficulties of nursing care were determined as early as possible, and corresponding intervention measures were provided.

3.2 Strengthening airway management, developing SOP for T-piece, and improving pulmonary infection

Respiratory system infection is one of the most common complications in stroke patients and a major cause of death [4]. After being transferred from the ICU to the neurosurgery ward, the patient's chest CT indicated pulmonary infection, with grade II yellow viscous sputum. Airway management was the focus of this nursing care. Relevant literature reviews suggested that the patient should receive low-flow continuous airway humidification instead of a heat and moisture exchanger; reasonable airway humidification for the patient is crucial to ensuring effective ventilation and preventing complications [5,6].

Specific measures were as follows:

(1) The patient's heat and moisture exchanger was replaced with a T-piece device connected to an oxygen source. The oxygen flow rate was adjusted to 5 L/min, the oxygen concentration to 40%, and continuous airway humidification was provided using 0.45% sodium chloride solution as the humidifying fluid. A standard SOP for the use of the T-piece humidification device was developed;

(2) Nebulization therapy was administered to the patient 3 times a day, with dynamic observation of sputum viscosity, volume, and the presence of cough reflex;

(3) The head of the bed was elevated by 30–45°, and airbag pressure was monitored every 4 hours (Q4H), maintaining a pressure of 25–30 cmH_2O;

(4) Tracheostomy care was performed once a day, with strict adherence to the principle of aseptic technique;

(5) Airway suctioning was performed as needed. Each suctioning procedure was strictly completed within 15 seconds, with a maximum of 2 consecutive suctions, and a suction pressure of 100 mmHg to avoid excessive negative pressure in the airway;

(6) Oral care was provided to the patient every 8 hours (Q8H) using normal saline, povidone-iodine gargle, and a negative-pressure suction toothbrush. Changes in oral mucosa, odor, and pH were monitored. The patient's oral pH fluctuated between 6.6 and 7.0, and no oral inflammation occurred [4].

On the 16th postoperative day, re-examination CT showed that the patient's pulmonary infection gradually improved, and the sputum changed from grade II yellow viscous sputum to grade I white sputum.

3.3 Emphasizing postoperative volume management and implementing individualized care to prevent complications

Patients with aneurysmal subarachnoid hemorrhage require appropriate dehydrating agents to reduce intracranial hypertension and improve cerebral edema, which often leads to relative hypovolemia and hypotension. Therefore, postoperative volume management was also a focus of this nursing care. The latest evidence-based recommendations advocate maintaining normal circulating blood volume and conducting fluid balance management to optimize cerebral perfusion and cerebral oxygenation, which helps reduce the occurrence of various complications [7].

Combined with the patient's individual conditions and relevant literature, an individualized nursing plan was formulated as follows:

(1) Early administration of nimodipine was initiated as prescribed by the doctor. The patient's vital signs, consciousness, pupil status were closely observed, and electrolyte levels, fluid intake/output, and body weight were monitored;

(2) Fluid intake was adjusted based on indicators such as urine output, blood pressure, central venous pressure, and electrolyte levels. Fluid loss was assessed 2–3 times daily to determine the total fluid replacement volume [8]. On the 8th postoperative day, the patient's serum sodium level was 159.6 mmol/L. According to the fluid replacement principle for hypernatremic patients: Fluid replacement volume = Total Body Water (TBW) × (Serum sodium concentration/Target serum sodium concentration - 1) + Insensible water loss, TBW: 60% of body weight for males, 50% of body weight for females, Insensible water loss: usually 30–50 mL/h or 10 mL/(kg·d) [9,10]. The calculated total fluid replacement volume was: (0.5 × 65) × (159.6/149.6 - 1) + 1200 = 3371 mL. The total daily fluid replacement volume was dynamically adjusted according to the patient's condition to maintain a roughly balanced fluid intake and output. On the 16th postoperative day, the patient's serum sodium was 144.5 mmol/L and serum chlorine was 105.1 mmol/L. On the 22nd postoperative day, the patient was discharged without electrolyte disturbance, and no complications such as cerebral edema or cerebral infarction were found on cranial CT.

3.4. Preventing thromboembolism to maximize patient benefits

Patients with aneurysmal subarachnoid hemorrhage are at high risk of thromboembolism, while rebleeding of intracranial aneurysm is an important factor affecting their prognosis [11]. Therefore, dynamically adjusting anticoagulation strategies to prevent both bleeding and thromboembolism was the difficulty of this nursing care. On the 2nd postoperative day, lower extremity color Doppler ultrasound showed local calf muscle venous thrombosis in the right leg; on the 7th postoperative day, re-examination of lower extremity color Doppler ultrasound showed no abnormalities. On the 8th postoperative day, the patient was transferred to our ward.

Assessment indicated she was a postoperative patient with disturbance of consciousness, a history of deep vein catheterization, and long-term bed rest. Laboratory indicators showed: D-dimer 13.56 mg/L, fibrinogen 6.06 g/L. Therefore, the following measures were taken:

(1) Dynamic re-evaluation of Caprini thromboembolism risk score, monitoring of blood indicators, and re-examination of lower extremity color Doppler ultrasound;

(2) A consultation with the rehabilitation department was requested to implement early bedside rehabilitation;

(3) Basic prevention: 100 mL warm water via nasogastric tube every 8 hours (Q8h), elevation of both lower extremities, measurement of leg circumference, regular observation of dorsalis pedis artery pulse, skin

color, and temperature;

(4) Mechanical prevention: wearing elastic stockings on both lower extremities, and 30-minute air pressure therapy twice a day (BID). On the 10th postoperative day, re-examination of lower extremity color Doppler ultrasound showed local calf muscle venous thrombosis in the right leg. Relevant consensuses point out that to reduce the occurrence of thromboembolism, unfractionated heparin or low-molecular-weight heparin sodium can be used as appropriate after aneurysm clipping until the patient can ambulate, and intermittent pneumatic compression should be performed within 24 hours [11].

Therefore, treatment included subcutaneous injection of enoxaparin sodium 2000 units once daily (QD) and intravenous administration of batroxobin injection 5 BU every other day (QOD) as prescribed. Additional nursing measures were:

(1) Observing the injection site for petechiae, and checking for gingival bleeding, hematemesis, and hematochezia;

(2) Maintaining skin cleanliness; prohibiting hot compresses, massages, and air pressure therapy on the affected limb to prevent thrombus dislodgment;

(3) Performing air pressure therapy on the patient's unaffected lower extremity for 18 hours/day, with an inflation pressure of 35–40 mmHg and a leg cuff length reaching the root of the thigh;

(4) Ensuring the elastic stockings were removed for no more than 30 minutes per day [12–14].

On the 12th postoperative day, pulmonary artery CTA showed local branch embolism in the right middle and lower lobes of the lung. The D-dimer level was 24.26 mg/L, and fibrinogen was 1.48 g/L. A consultation with the respiratory department was requested, and the patient's anticoagulation strategy was adjusted: enoxaparin sodium was changed to 4000 units QD subcutaneously as prescribed. Additional nursing measures included:

(1) Preparing a simple manual resuscitator and defibrillator at the bedside;

(2) Closely monitoring the patient's vital signs, with particular attention to respiration, heart rate, and blood pressure;

(3) Strengthening airway management; prohibiting back patting and deep suctioning;

(4) Immediately reporting to the doctor and actively cooperating with rescue if the patient developed dyspnea, chest pain, hemoptysis, or arrhythmias of varying degrees such as tachycardia or atrial fibrillation;

(5) Maintaining timely communication between medical and nursing staff, dynamically monitoring indicators such as D-dimer, prothrombin time, fibrinogen, and platelets, and adjusting the treatment plan promptly.

No further bleeding events or new thrombi occurred during the patient's subsequent treatment.

4. Conclusion

Patients with PE complicated by ruptured IA after clipping surgery have complex conditions, with high mortality and disability rates. The overlapping risk factors of bleeding and thromboembolic events in this patient posed challenges to the nursing care. Based on standardized assessment and close condition observation, an individualized nursing plan was formulated for the patient. Meanwhile, through multidisciplinary collaboration and dynamic adjustment of anticoagulation strategies and nursing plans, the occurrence of postoperative complications was reduced, and the patient's hospital stay was shortened. In addition, by analyzing the shortcomings in the nursing process of this patient, we recognized that formulating nursing measures based on evidence-based practice is crucial for promoting patient recovery. The department organized learning and training on evidence-

based nursing knowledge, which ensured the scientificity, effectiveness, and orderliness of nursing work, and also provided a reference for the nursing of similar patients in the future.

Disclosure statement

The authors declare no conflict of interest.

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