Special Clinical Care

Jian Luo

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7.1 Oxygen Therapy for Critically Ill Patients

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7.1.1 Closely Monitoring the Disease [1–3]

Monitoring patient’s vital signs, especially the changes in consciousness, respiratory rate, oxygen saturation, etc.

Patient’s symptoms such as cough, expectoration, chest tightness, dyspnea, and cyanosis. Should be surveyed, and blood gas analysis should be dynamically monitored. Severe cases of patients should be provided with oxygen by nasal cannula or facial mask and be assessed timely if relieved from respiratory distress and/or hypoxemia.

Oxygen therapy through high-flow nasal cannula (HFNC) or noninvasive mechanical ventilation: When respiratory distress and/or hypoxemia of the patients cannot be relieved after the patients receive standard oxygen therapy, high-flow nasal cannula or noninvasive ventilation can be considered. If it does not improve or even worsens in a short period of time (1–2 h), tracheal intubation and invasive mechanical ventilation shall be performed as soon as possible.

Invasive mechanical ventilation: Mechanical ventilation should be provided by lung protective ventilation strategy, i.e., low tidal volume (6–8 mL/kg ideal body weight) and low-level airway plateau pressure ($P_{\text{plat}}$ 30 cm H$_2$O), so as to reduce ventilator-related lung injuries. While ensuring the airway plateau pressure of 35 cm H$_2$O, PEEP can be adopted appropriately. The airway should be kept humidified and warm. Long-time sedation should be avoided. Patients should be woken up early and lung rehabilitation treatment should be carried out. In the situation of patient–ventilator asynchrony, sedatives and muscle relaxants should be used timely. Sealed endotracheal suctioning should be carried out based on the condition of airway secretions. If necessary, bronchoscopy should be performed and corresponding treatment should be provided.

7.1.2 Care of Patients Receiving High-Flow Nasal Cannula

High-flow (maximum 60–80 L/min) gas with relatively constant inspiratory oxygen concentration (21–100%), temperature (31–37 °C), and humidity should be provided to the patients, and oxygen therapy is provided by nasal plug [2].

7.1.2.1 Indications

When respiratory distress and hypoxemia cannot be improved after oxygen is supplied by nasal cannula or mask, mild-moderate type I respiratory failure ($100 \text{ mmHg} \leq \text{FiO}_2 < 300 \text{ mmHg}$), mild respiratory distress ($\text{RR} > 24 \text{ times/min}$), no indication for emergent tracheal intubation, supporting ventilator removal and extubation.
7.1.2.2 Relative Contraindications
Severe type I respiratory failure (FiO₂ < 100 mmHg), ventilatory disorder (pH < 7.35), paradoxical breathing, poor airway protection ability, high risk of aspiration, unstable hemodynamics, multiple organ dysfunction syndrome (MODS), abnormal mental state, requiring vasoactive drugs, patients who cannot wear HFNC due to surgery on the face or the upper respiratory tract, severe nasal obstruction, HFNC intolerance.

7.1.2.3 Absolute Contraindications
Patients whose heart beat and breath suddenly stop, requiring emergent invasive ventilation; patients with weak spontaneous respiration; patients with extremely severe type I respiratory failure (FiO₂ < 60 mmHg); ventilatory disorder (pH < 7.25).

7.1.2.4 Clinical Operation

7.1.2.4.1 Temperature Setting
The initial temperature for patients without tracheotomy should be set at 31–34 °C and can be appropriately adjusted based on the comfortability and viscosity of sputum; the initial temperature for patients with tracheotomy should be set at 37 °C.

7.1.2.4.2 Flow Rate
The initial flow rate should be set at 35–45 L/min. Titrate the inhaled oxygen concentration to maintain the oxygen saturation above 93%. The flow rate and oxygen concentration should be dynamically adjusted according to the result of blood gas analysis.

7.1.2.4.3 Criteria for HFNC Removal
HFNC parameters should be gradually decreased after the primary disease is under control. If HFNC < 25 L/min FiO₂ < 30% can be reached, the therapy can be changed to oxygen supply by nasal cannula.

7.1.2.4.4 Precautions
(1) Before connection of the machine, the doctor should communicate with the patient, explaining the purpose of the treatment and obtaining consent from the patient. (2) Body position: Semi-reclining position is recommended. (3) Appropriate model of nasal plug should be used and nasal cannula smaller than 50% of the inner diameter of the nostril is recommended. Reduced pressure dressing should be applied first upon use and the tightness of the fixing strap for nasal plug should be adjusted appropriately to avoid device-related pressure injury on the facial skin [2]. (4) Patients who open their mouths for breathing should be instructed to breathe with mouth closed. If they cannot cooperate, the therapy can be switched to nasal mask. (5) Over-humidification and under-humidification should be avoided, character of gas secretions should be closely observed, and sputum suction should be carried out as needed. (6) Attention should be paid to water accumulation in the tubing. (7) Attention should be paid to observe the changes in vital signs, form of respiratory
movement, and blood gas analysis during usage to avoid delayed intubation. (8) Attention should be paid to adjust the tightness of the nasal plug. (9) Attention should be paid to various warnings during usage and their timely handling. (10) After treatment with HFNC (within 1~2 h), the efficacy and reactions should be closely monitored. The other supporting methods should be used if the following conditions occur continuously: unstable hemodynamics, obvious movement of auxiliary ventilator, deterioration of consciousness, RR > 35 times/min, SpO₂ < 90%, large quantity of airway secretions, combined PCO₂ > 45 mmHg, pH < 7.35, etc. In such conditions, the doctor should be informed; consider stopping HFNC oxygen therapy and providing mechanical ventilation timely by tracheal intubation [3, 4].

7.1.3 Disposal of Secretions

Patients should wipe their saliva, nasal discharge, and sputum on their own or under the assistance of the nurse. The secretions should be wrapped and discarded into a closed disposable container prefilled with disinfectant containing 2500 mg/L of chlorine. For patients requiring mechanical suction, the sputum should be sucked into a collector prefilled with disinfectant containing 2500 mg/L of chlorine. If patients accidently spill excretions on the ground or surface of an object, gloves should be worn, and moisture absorption method (high-quality tissue is recommended) should be used first to remove visible contaminants and then 1000 mg/L effective chlorine containing disinfectant should be used to wipe for 30 min before wiping with clean water. Cleaned secretions should be centralized and disposed of as medical wastes.

7.2 Care of Patients Receiving Mechanical Ventilation

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7.2.1 Cooperation for Tracheal Intubation

The number of doctors and nurses required for ensuring the safety of the patients should be limited, and positive pressure headgear should be worn [4]. Before intubation, analgesia and sedation should be carried out, and muscle relaxation should be performed as needed. Meanwhile, hemodynamics should be monitored well. Within 30 min postoperation, staff movement in the room should be reduced, and continuous plasma air purification should be carried out for disinfection.

7.2.2 Management of Analgesia, Sedation, and Deliriation

The objective of analgesia and sedation should be determined daily. Analgesia degree should be evaluated Q4h (CPOT) and sedation be evaluated Q2h (RASS/BISS).
The analgesics and sedatives should be adjusted accordingly. Pre-analgesia should be carried out before operation that specifically causes pain. CAM-ICU delirium screening should be carried out at each shift so as to identify positive patients as early as possible. Bundle strategy for prevention of delirium should be implemented: pain handle, minimize sedation, communication, sleep promotion, early activity, etc. [1, 3]. After sedative and analgesic drugs are administered, the effects, circulation, and breathing conditions should be closely observed and recorded regularly.

### 7.2.3 Prevention of VAP [1, 3, 5]

VAP prevention bundle should be implemented, including following the hand hygiene system; raising the bed head of the patient by 30~45° if not contraindicated; performing oral care every 4~6 h; using disposable saliva absorption toothbrush; maintaining cuff pressure at 25~30 cm H₂O and monitoring every 4 h; providing nutrient solutions by gastric tube and monitoring residual amount in the stomach every 4 h; evaluating if the machine can be removed every day; using flushable tracheal catheter to continuously suck secretions under the glottis at low negative pressure, with pumping by 10 mL syringe intermittently q1h~q2h; and adjusting the suction frequency based on the actual quantity of secretions on the cuff. For residues under the glottis, 10 mL syringe should be used to suck the secretions on the cuff and then immediately suck appropriate amount of disinfectant containing 2500 mg/L of chlorine. Then the needle cap should be connected, and the syringe should be placed into a sharps box. It is recommended to use disposable ventilator circuit. Conventional replacement is not recommended, and the circuit should be timely replaced in case of contamination. Heat moisture exchanger should be replaced every 5~7 days and should be immediately replaced in case of contamination or failure.

### 7.2.4 Aspiration of Sputum

Aspiration of sputum: Closed endotracheal suctioning and closed disposable sputum collection bag should be used to reduce aerosol and droplets. Pure oxygen should be provided for patients for 2 min pre- and post-aspiration of sputum, and the duration of aspiration should not exceed 15 s.

Collection of sputum specimen: sputum collection device with closed endotracheal suctioning tube should be used to reduce exposure to droplets.

Observation and record: Attention should be paid to the vital signs of the patients and the character, color, and quantity of sputum.

### 7.2.5 Disposal of Condensate Water of Ventilator Tube [2, 3, 6]

It is recommended to use ventilator tubelines with disposable double circuit through heating guide wire and automatic water filling humidification tank to reduce the generation of condensate water.
When the ventilator tubeline is provided with the water collection cup, the position of the ventilator tubeline should be kept lower than the artificial airway, and the water collection cup at the circuit end should be at the lowest position for the drainage of condensate water, which should be poured in time. Capped container should be prefilled with disinfectant containing 2500 mg/L of chlorine. Two people are needed to cooperate in transferring of the accumulated water within the tube into the capped container and then directly dumped into a cleaning machine whose temperature can reach 90 °C for automatic cleaning and disinfection.

Before pouring the condensate water, nursing staff shall be well protected. It is recommended to press the standby key of the ventilator to stop ventilation before pouring. Then directly disconnect the ventilator near the gas outlet end of the ventilator before pouring. The purpose is to avoid accidental splashing of condensate water, which will contaminate the nursing staff, or to avoid the condensate water from going back into the airway of the patient.

7.2.6 Prone Position Ventilation [1, 4, 7]

Preparation before turning over: Sedative and analgesic drugs should be used in accordance with the prescriptions; gastric retention should be evaluated and enteral nutrition should be stopped in advance; secretions in the mouth, nose, and airway should be cleaned; unnecessary venous access should be disconnected and catheter should be properly fixed; preventive anti-stress dressing should be used to protect the stressed skin; electrode slice should be replaced.

During turning over: At least five medical staff should cooperate, one staff in charge of the head, responsible for tracheal intubation and coordinating the turning action of others, and two staff members at each side of the patient. The patient should be placed at a lateral position first and then changed to prone position to make sure that the chest, hip, and knee joint fall on a polymer pad or soft pillow to avoid pressing. The head of the patient should be tilted to one side, and a U-shaped pad should be placed under the stressed side of the head so as to prevent the tracheal tube from being stressed. The upper limbs of the patient should be in parallel with the body or slightly abducted, with the forearms placed upward at the head side or downward at both sides of the body. The functional position should be maintained, and brachial plexus injury caused by ischemia due to stretching and squeezing should be avoided. The heart rate and oxygen saturation should be monitored during turning; catheters should be protected to prevent detaching.

After turning over: Instruments should be connected and infusion should be resumed; catheters should be properly fixed; body position should be adjusted every 2 h; the skin and blood supply at the stressed skin should be observed to avoid stress injury.
7.2.7 Prevention of Aspiration [1, 3]

Monitoring and care of gastric retention: Postpyloric feeding with feeding pump should be continued to reduce gastroesophageal reflux. If conditions allow, gastric motility and gastric retention should be evaluated by ultrasound. Conventional evaluation is not recommended for patients with good gastric emptying.

Gastric retention amount should be evaluated every 4 h: Refeed if gastric retention amount is less than 100 mL, and report to the doctor if the gastric retention amount is more than 100 mL before making any decision.

Prevention of aspiration during transfer: Nasal feeding should be stopped before transfer; residual amount in the stomach should be withdrawn. The stomach tube should be connected with negative pressure bag for drainage; during transfer, the bed head should be raised by 30°.

Prevention of aspiration for patients receiving nasal high-flow oxygen therapy: Inspection should be carried out every 4 h to avoid and timely handle over-humidification or under-humidification and water accumulation in the tubeline. Attention should be paid to coughing and aspiration caused by entry into airway by mistake. The nose plug should be maintained at a position higher than the machine and tubeline, and condensate water of the tubeline should be handled in a timely manner.

7.2.8 Prevention of Stress Ulcer, Gastrointestinal Bleeding, and ICU Acquired Weakness [3]

Early identification of population with high risk of stress ulcer: When mechanical ventilation ≥ 48 h, those receiving renal replacement therapy and those with liver disease, combination of multiple complications, high organ failure score, blood coagulation disorders, etc. are all population with a high risk of stress ulcer.

Enteral nutrition in the early stage (24–48 h after hospitalization).

The color of the gastric drainage should be closely observed; during enteral nutrition, contents in the stomach can be withdrawn to observe their color; attention should be paid to the occult blood test results and the color of stool.

In the early disease stage or stable disease stage, conscious patients should be instructed to actively carry out activities of extremities. Patients with disturbance of consciousness should be provided with passive movement to prevent muscular atrophy and muscular weakness.

7.3 Routine Management and Monitoring of ECMO

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ECMO perfusionist should manage, check, and record the following hourly: rotation speed, blood flow, oxygen flow, oxygen concentration, if temperature controller
is rotating and flowing and setting as well as the actual temperature, if blood clots are developed in the membrane oxygenation, if tubing is twisted and stressed, if venous tubeline is shaking, if the urine of the patient turns red or dark brown.

*Check and record the following at each shift*: Catheterization depth, tubeline fixing condition, if interfaces are firm, water level of temperature controller, power supply of the machine, gas supply connection, check if there is oozing and swelling at the puncture site at each shift, measure the thigh circumference of both lower limbs, observe if there is swelling of the lower limb at the operation side, and observe peripheral perfusion, such as pulsation of dorsal pedal artery, skin temperature, and color. Function of ECMO oxygenator should be evaluated at each shift.

*Anticoagulation management*: The purpose of ECMO anticoagulation is to prevent thrombosis and reduce the risk of bleeding. Common anticoagulation method: heparin anticoagulation. During rotating and flowing, heparin sodium should be used for maintenance (4–30 U/kg/h), heparin should be continuously pumped in to maintain ACT at 180–200 s; the number of skin punctures should be minimized during anticoagulation. Procedures should be gentle and bleeding status should be closely observed.

### 7.3.1 Daily Monitoring

Blood gas analysis: Blood gas analysis should be performed once every 3 h after stabilization. \( \text{PaO}_2 \) should be maintained at 80–120 mmHg and \( \text{PaCO}_2 \) at 35–45 mmHg.

ACT: ACT should be monitored once every hour in the early stage, and once every 3–6 h after ACT stabilized [1].

Body temperature: Body temperature should be monitored once every 4 h and maintained at 36–37 °C to avoid the increase of oxygen consumption caused by high body temperature and disorder of coagulation mechanism and hemodynamics [1].

Blood pressure: The blood pressure during ECMO may be low, especially in the initial stage. MAP of 50–60 mmHg should be maintained during the operation of ECMO.

For urine volume, the excess water during ECMO should be excreted through the kidney if possible. Urine volume should be maintained at >1 mL/(kg·h), and drugs and CRRT therapy can be used as needed. In addition, attention should also be paid to the fluid loss during ECMO. Fluid can be properly replenished based on central venous pressure, skin elasticity, etc.

*The “lung super protective ventilation” strategy should be implemented*: Ventilator-related lung injuries should be avoided or reduced as much as possible. It is recommended that the initial tidal volume should be <6 mL/kg. The spontaneous breathing strength should be preserved and the respiratory rate be maintained at 10–20 times/min.

*Tubing management*: Tubeline should be firmly fixed to avoid detaching and twisting; the tube will shake when the drainage of venous tubeline is open and blood
cannot be withdrawn; hemolysis is likely to occur when the negative pressure is too high (above $-30$ mmHg); pump should be stopped before operation of negative tube system.

*Management of pump:* The base of centrifugal pump will generate heat and thrombus is likely to develop. When the revolutions are inconsistent with the flow or when hemoglobinurias, etc. appear, it indicates that there may be formation of thrombus. If thrombus develops, abnormal sound of the pump can be heard with a stethoscope.

*Infusion management:* If possible, fluid infusion and blood transfusion should be carried out after the ECMO. Infusion of those drugs as fat emulsion and Propofol should be avoided.

*Infection control:* For ECMO, regular air disinfection is required for the ward, and antibiotics should be given for a long term to prevent infection. Attention should be paid on sterile operation and hand hygiene.

### 7.3.2 Equipment Management During Operation

The water supply, gas supply, and power supply on the tubeline should be checked regularly.

The tubeline should be checked regularly. Power flashlight can be used to check the tubeline and if there is thrombosis on the membrane oxygenation.

The water line of the water temperature tank should be correctly checked.

Whether abnormal sound appears should be observed for the pump head. If there is abnormal sound, it indicates that the pump head is not stably placed in the actuator. The circulation should be stopped and the pump head be removed for replacement.

### 7.3.3 Management of Common Complications

Equipment failure and pump shutdown: Hand pump should be used to ensure ECMO circulation and safety of the patient. The doctor/perfusionist should be notified and troubleshooting should be carried out. If necessary, instrument should be replaced and the failed one should be sent for repair.

Abnormal function of oxygenator: It is manifested as gas exchange failure, plasma leakage, and thrombosis formation. Hand pump should be used to immediately prefill the new tubeline. The whole set of tubeline should be replaced. The whole team should work together to shorten the shutdown period and ensure safety of the patient.

Air embolism: It is often caused by inappropriate drainage, high negative pressure, cannula displacement, misoperation, etc. The small yellow cap at the venous end/before the membrane should be immediately removed and observation should be strengthened (if there is gas after the membrane). The etiology should be screened. In the case of large volume of gas entry, the circulating gas outlet at the
artery end/after the membrane should be stopped. The blood flow should be blocked to prevent the gas from entering the body of the patient. Gas exhaust treatment should be carried out. If necessary, the tubeline should be replaced.

Hemorrhage and hemolysis [1, 8]: Cerebral hemorrhage should be determined by observing the size of the pupil of the patient and other methods. Gastric hemorrhage should be determined by withdrawing the gastric residues and observing the color. Intestinal bleeding should be determined by stool examination. If scleral icterus or jaundice, positive urine occult blood test, coke-colored urine or oliguria, etc., hemolysis or acute kidney injury should be suspected. It is recommended to report to physician for treatment instantly.

7.4 Care of Artificial Liver

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The care of artificial liver is mainly divided into care during the treatment and care in the intermittent phase. Nursing staff should closely observe the disease condition, standardize the operation procedure, and focus on key points and timely handle complications so as to smoothly complete the artificial liver treatment.

7.4.1 Care During the Treatment

Care during the treatment refers to the care during each artificial liver performance. The overall operation procedure can be summarized as follows: Preparation of operator–patient evaluation–machine installation–prefilling–connection of the machine–detaching of the machine record. The key points for care in each step are provided below:

1. Preparation for operators: Protective measures of level III and above should be comprehensively implemented.
2. Patient evaluation: Including clinical status and disease condition of the patient, especially allergic history, blood glucose, coagulation function, oxygen therapy condition, and sedation state. Attention should be paid to the psychological state of conscious patients.
3. Evaluation of catheter state: Routine sterile procedures are recommended during disinfecting the deep venous catheter and wound; draw 2 mL of residual heparin saline from the artery lumen with a 5 mL syringe, push it onto the gauze, and check if there is blood clot; check if 20 mL blood (blood flow is about 200 mL/min) can be withdrawn from the artery lumen with a 20 mL empty syringe in 6 s, push in and repeat once, and then test the blow flow in the artery lumen of the catheter; wash the artery end of the catheter clean with 10 mL of saline; and check the venous end of the catheter by the same method.
4. Installation and prefilling: If possible, closed loop should be used for the treatment tubing and consumables to avoid exposure of the blood and body fluid of
the patient; corresponding instrument, tubing, and other consumables should be selected in accordance with the treatment mode. Medical staff should be familiar with the basic performance of the treatment consumables.

5. Connection of the machine: It is recommended that the initial blood leading speed be ≤ 50 mL/min to avoid hypotension caused by high velocity; vital signs should be monitored in a timely manner.

6. Parameter adjustment: After extracorporeal circulation becomes stable, treatment parameters and alarm parameters should be adjusted in accordance with the treatment mode; in the early stage, sufficient anticoagulant should be used and the maintenance volume should be adjusted at any time based on the treatment pressure.

7. Detaching of the machine: The liquid plus gravity combined recovery method should be used; the recovery rate should be ≤ 50 mL/min; after detaching, medical wastes should be disposed and treatment instruments should be cleaned and disinfected in accordance with the prevention and control requirements for SARS-CoV-2 infection.

8. Record: Vital signs of the patient, dosing condition of artificial liver, artificial liver treatment parameters, and remarks of special conditions should be correctly recorded.

### 7.4.2 Care During the Intermittent Phase

The appearance of hypotension, hemorrhage, coagulation in the catheter in the early stage after treatment and allergic reaction, disequilibrium syndrome, and thrombosis formation in the late stage should be closely observed [9, 10].

Care of artificial liver catheterization: Local condition should be observed and recorded at each shift; catheter-related thrombus should be prevented; professional maintenance of catheter should be carried out every 24 h; access should be fixed properly to avoid twisting and stressing.

Withdrawal of artificial liver catheter: Ultrasound examination of blood vessel should be carried out before withdrawal; after catheter withdrawal, the lower limb at the insertion side should be retaining for 6 h and the patient should stay in bed for 24 h; local trauma should be observed after catheter withdrawal.

### 7.5 CRRT Care

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#### 7.5.1 Pretreatment Preparations

Preparation of patient: Effective vascular access should be established before CRRT. Generally, central venous catheterization through jugular vein is preferred. If ECMO therapy is planned at the same time, CRRT therapy can be integrated into
the ECMO system. The equipment, consumables, and medications for ultrafiltration are prepared ahead.

Catheter evaluation: Disinfecting the deep venous catheter and wound according to general aseptic operation procedure; draw 2 mL of residual heparin saline from the artery lumen with a 5 mL syringe, push it onto the gauze, and check if there is a blood clot; check if 20 mL blood (blood flow is about 200 mL/min) can be withdrawn from the artery lumen with a 20 mL empty syringe in 6 s, push in and repeat once, and then test the blow flow in the artery lumen of the catheter; wash the artery end of the catheter clean with 10 mL of saline; and check the venous end of the catheter by the same method.

**7.5.2 Care During Treatment**

Maintenance of vascular access: Before accessing the catheter, the state of the catheter should be evaluated. During use, tubing should be properly fixed to avoid twisting and stressing.

The machine control system should be adjusted. The blood flow velocity in the beginning of dialysis should be slow (50 mL/min), then can be gradually increased, and reach 200 mL/min in about 15 min. After the blood flow becomes stable, alarm thresholds should be set.

The consciousness of patients and changes in vital signs should be closely monitored and the in- and output of fluid should be correctly calculated; the coagulation condition of extracorporeal circulation should be closely observed and alarms should be effectively handled to ensure smooth operation of the machine; blood gas should be monitored and analyzed every 4 h; and acid–base equilibrium of electrolytes in the internal environment should be evaluated.

The aseptic operation principle should be strictly applied and hand hygiene should be strictly implemented. The aseptic operation principle should be strictly followed for the configuration of substitution fluid. Substitution fluid should be prepared upon use, with clear label.

Observation of common complications: (1) hypotension: it is related to too much and rapid ultrafiltration dehydration, insufficient blood volume, cardiogenic shock, inhibition of acetate to myocardium, or allergy. It may be accompanied by nausea, vomiting, pale complexion, chest tightness, sweating, and even transient loss of consciousness. (2) Disequilibrium syndrome: It is likely to occur when patients have severe azotemia with high content of urea and is manifested as headache, nausea and vomiting, hypertension, convulsion, and coma for severe patients. (3) Pyrogenic reaction: Often occurs 1 h after the beginning of dialysis. It is caused by endotoxin entering the body and manifested as chill followed by fever. (4) Hemorrhage: It is often caused by the application of heparin, platelet dysfunction, and hypertension. It is often manifested as nasal bleeding, gum bleeding, gastrointestinal hemorrhage, intracranial haemorrhage, etc.

Record: Arterial pressure, variceal pressure, transmembrane pressure, blood flow rate, rate of substitution fluid, ultrafiltration volume, and other indicators should be recorded hourly.
7.5.3 Care Posttreatment

Blood routine, liver and kidney function, and coagulation function of the patient should be monitored.

Maintenance of indwelling catheter: Indwelling catheter should be properly fixed and flushed and sealed regularly. Catheter puncture point should be covered with sterile dressing, and dressing change should be carried out regularly. Upon dressing change, attention should be paid to the skin around the opening of the catheter for redness, swelling, warmness, tenderness, and blood and fluid leakage.

Equipment in continuous operation should be wiped and disinfected every 24 h, and consumables and waste liquid should be disposed in accordance with the hospital’s requirements for prevention of infection.

7.6 Care of PICC, CVC, and Medium-Long Catheter

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7.6.1 Preparation Before Catheterization

Level III protection should be provided for operators. Absolute contraindications should be avoided. During catheterization, technical specification for sterile operation should be strictly followed and needle stick injuries should be prevented.

7.6.2 Care During Use [10]

Catheter should be flushed with 20 mL of saline by impulsion and positive pressure before usage. Flushing and dosing with syringe less than 10 mL should be avoided. Violent flushing should be avoided to prevent damaging the catheter.

The sterile operation procedure should be strictly followed. Dressing and the positive pressure joint should be replaced every 7 days. Dressing change should be carried out timely in case of edge curling, looseness, and sweating under the sticking film dressing. Positive pressure joint should be replaced immediately after catheter flushing after blood infusion, blood drawing, and infusion of such high-viscosity drugs as fat emulsion.

The responsible nurse should observe the condition of the catheter at each shift to avoid detaching of the catheter, redness, swelling, warmness, tenderness, leakage, etc. around the needle eye, and discover and solve these problems as early as possible.

Blood pressure measurement at the limb of the catheter side should be avoided. Patients should be instructed to carry out functional exercise every day to avoid thrombus.
Care of post-catheter withdrawal: The insertion site should be pressed for 10 min after catheter withdrawal, and the wound be locally sealed with sealing gauze and transparent film dressing for 48 h. As the puncture hole at the vascular access is big, movement stretching should be prevented to prevent air from entering or bleeding of the wound.

Preventive measures for implementing unplanned catheter withdrawal. Adverse safety events arising from withdrawing and environmental contamination by aerosol during withdrawal should be avoided.

“Patient health questionnaire PHQ-9 risk evaluation” should be carried out when the patients are admitted to the hospital. High-risk patients should be screened and mental care be provided for patients. Take care of patients’ psychological changes.

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