Part Three Nursing

I. Nursing Care for Patients Receiving High-Flow Nasal Cannula (HFNC) Oxygen Therapy

1 Assessing

Provide detailed information of the HFNC oxygen therapy to get the patient’s cooperation before implementation. Use low dose sedative with close monitoring if necessary. Choose a proper nasal catheter based on the diameter of the patient’s nasal cavity. Adjust the head strap tightness and use decompression plaster to prevent device-related pressure injuries on the facial skin. Maintain the water level in the humidifier chamber. Titrate the flow rate, the fraction of inspired oxygen (FiO₂), and the water temperature based on the patient’s respiratory demands and tolerance.

2 Monitoring

Report to the attending physician to seek medical decision of replacing HFNC by mechanical ventilation if any of the followings occur: hemodynamic instability, respiratory distress evidenced by obvious contraction of accessory muscles, hypoxemia persists despite oxygen therapy, deterioration of consciousness, the respiratory rate > 40 breaths per minute continuously, significant amount of sputum.

3 Treatment of Secretions

Patients’ drool, snot, and sputum should be wiped with tissue paper, be disposed in a sealed container with chlorine-containing disinfectant (2500 mg/L). Alternatively, secretions can be removed by oral mucus extractor or suctioning tube and be disposed in a sputum collector with chlorine-containing disinfectant (2500 mg/L).

II. Nursing Care for Patients with Mechanical Ventilation

1 Intubation Procedures

The number of the medical staff should be limited to the minimum number that can ensure the patient’s safety. Wear powered air-purifying respirator as PPE. Before intubation, perform administration of sufficient analgesia and sedative, and use muscle relaxant if necessary. Closely monitor the hemodynamic response during intubation. Reduce movement of staff in the ward, continuous purify and disinfect the room with plasma air purification technology for 30 min after completion of intubation.
2 Analgesia, Sedation and Delirium Management

Determine the target pain management goal every day. Assess pain with every 4 hours (Critical-Care Pain Observation Tool, CPOT), measure sedation with every 2 hours (RASS/BIS7). Titrate the infusion rate of analgesics and sedatives to achieve pain management goals. For the known painful procedures, preemptive analgesia is administered. Perform CAM-ICU delirium screening in every shift to ensure an early diagnosis of COVID-19 patients. Apply centralization strategy for delirium prevention, including pain relief, sedation, communication, quality sleep, and early mobilization are used.

3 Prevention of Ventilator-Associated Pneumonia (VAP)

The ventilator bundle is used to reduce VAP, which includes hand washing; raising the tilt angle of the patient’s bed by 30-45° if no contradiction is presented; oral care every 4 to 6 hours by using a disposable oral mucus extractor; maintain endotracheal tube (ETT) cuff pressure at 30-35 cmH₂O every 4 hours; enteral nutrition support and monitor gastric residual volume every 4 hours; evaluating daily for ventilator removal; using washable tracheal tubes for continuous subglottic suctioning combined with 10 mL syringe suctioning every 1 to 2 hours, and adjusting the suctioning frequency according to the actual amount of secretions. Dispose retentate below the glottis: the syringe containing the subglottic secretions is immediately used to aspirate an appropriate amount of chlorine-containing disinfectant (2500 mg/L), then be re-capped and disposed of in a sharp container.

4 Sputum Suction

(1) Use a closed sputum suction system, including closed suction catheter and closed disposable collection bag, to reduce the formation of aerosol and droplets.

(2) Collection of sputum specimen: use a closed suction catheter and a matching collection bag to reduce exposure to droplets.

5 Disposal of Condensation from Ventilators

Use disposable ventilator tubing with dual-loop heating wire and automatic humidifier to reduce the formation of condensation. Two nurses should cooperate to dump the condensation promptly into a capped container with chlorine-containing disinfectant (2500 mg/L). The container can then be directly put in a washing machine, which can be heated up to 90 °C, for automatic cleaning and disinfection.

6 Nursing Care for the Prone Position Ventilation (PPV)

Before changing the position, secure the position of tubing and check all the joints to reduce the risk of disconnection. Change the patient’s position every 2 hours.
III. Daily Management and Monitoring of ECMO (Extra Corporeal Membrane Oxygenation)

1. ECMO equipment should be managed by ECMO perfusionists and the following items should be checked and recorded every hour: Pump flow rate/rotation speed; blood flow; oxygen flow; oxygen concentration; ensuring that the temperature controller is flowing; temperature setting and actual temperature; preventing clots in circuit; no pressure to the cannulae and the circuit tubing is not kinked, or no “shaking” of ECMO tubes; patient’s urine color with special attention to red or dark brown urine; pre & post membrane pressure as required by the doctor.

2. The following items during every shift should be monitored and recorded: Check the depth and fixation of cannula to ensure that the ECMO circuit interfaces are firm, the water level line of the temperature controller, the power supply of the machine and the connection of the oxygen, the cannula site for any bleeding and swelling; measure leg circumference and observe whether the lower limb on the operation side is swollen; observe lower limbs, such as dorsalis pedis artery pulse, skin temperature, color, etc.


4. Anticoagulation management: The basic goal of ECMO anticoagulation management is to achieve a moderate anticoagulation effect, which ensures that certain coagulation activity under the premise of avoiding excessive activation of coagulation. That is to maintain the balance among anticoagulation, coagulation and fibrinolysis. The patients should be injected with heparin sodium (25-50 IU/kg) at the time of intubation and maintained with heparin sodium (7.5-20 IU/kg/h) during the pump flow period. The dosage of heparin sodium should be adjusted according to APTT results which should be held between 40-60 seconds. During the anticoagulation period, the number of skin punctures should be reduced as less as possible. Operations should be taken gently. The status of bleeding should be observed carefully.

5. Implement the “ultra-protective lung ventilation” strategy to avoid or reduce the occurrence of ventilator-related lung injury. It is recommended that the initial tidal volume is < 6 mL/kg and the intensity of spontaneous breathing is retained (breathing frequency should be between 10-20 times/min).

6. Closely observe the vital signs of patients, maintain MAP between 60-65 mmHg, CVP < 8 mmHg, SpO₂ > 90%, and monitor the status of urine volume and blood electrolytes.

7. Transfuse through the post membrane, avoiding infusion of fat emulsion and propofol.

8. According to the monitoring records, evaluate the ECMO oxygenator function during every shift.
IV. Nursing Care of ALSS (Artificial Liver Support System)

ALSS nursing care is mainly divided into two different periods: nursing care during treatment and intermittent care. Nursing staff should closely observe the conditions of patients, standardize the operating procedures, focus on key points and deal with complications timely in order to successfully complete ALSS treatment.

1 Nursing Care during Treatment

It refers to nursing during each stage of ALSS treatment. The overall operation process can be summarized as follows: operator's own preparation, patient evaluation, installation, pre-flushing, running, parameter adjustment, weaning and recording. The following are the key points of nursing care during each stage:

(1) Operator's own preparation
Fully adhere to Level III or even more strict protective measures.

(2) Patient assessment
Assess the patient's basic conditions, especially allergy history, blood glucose, coagulation function, oxygen therapy, sedation (for sober patients, pay attention to their psychological state) and catheter function status.

(3) Installation and pre-flushing
Use consumables with closed-loop management while avoiding the exposure to patient's blood and body fluids. The corresponding instruments, pipelines and other consumables should be selected according to the planned treatment mode. All basic functions and characteristics of the consumables should be familiarized.

(4) Running
It is recommended that the initial blood draw speed is ≤ 35 mL/min to avoid low blood pressure which might be caused by high speed. Vital signs should be monitored as well.

(5) Parameter Adjustment
When the patient's extracorporeal circulation is stable, all treatment parameters and alarm parameters should be adjusted according to the treatment mode. A sufficient amount of anticoagulant is recommended in the early stage and the anticoagulant dose should be adjusted during the maintenance period according to different treatment pressure.

(6) Weaning
Adopt "liquid gravity combined recovery method"; the recovery speed ≤ 35 mL/min; after weaning, medical waste should be treated in accordance to the SARS-CoV-2 infection prevention and control requirements and the treatment room and instruments should be cleaned and disinfected as well.

(7) Recording
Make accurate records of the patient's vital signs, medication and treatment parameters for ALSS and take notes on special conditions.
2 Intermittent Care

(1) Observation and treatment of delayed complications:
Allergic reactions, imbalance syndromes, etc.;
(2) ALSS Intubation Care:
Medical staff during each shift should observe the patient’s conditions and make records; prevent catheter-related thrombosis; carry out professional maintenance of the catheter every 48 hours;
(3) ALSS Intubation and Extubation Care:
Vascular ultrasonography should be performed before extubation. After extubation, the lower limb with the intubation side of patients should not be moved in 6 hours and the patient should rest in bed for 24 hours. After extubation, the surface of the wound to be observed.

V. Continuous Renal Replacement Treatment (CRRT) Care

1 Preparation before CRRT
Preparation for patient: establish effective vascular access. Generally, central vein catheterization is performed for CRRT, with the internal jugular vein preferred. A CRRT device can be integrated into the ECMO circuit if the two are applied at the same time. Prepare equipment, consumables, and ultrafiltration medication before CRRT.

2 In-treatment Care
(1) Vascular Access Care:
Perform professional catheter care every 24 hours for patients with central venous catheterization to properly fix access to avoid distortion and compression. When CRRT is integrated into ECMO treatment, the sequence and the tightness of the catheter connection should be confirmed by two nurses. Both the outflow and the inflow CRRT lines are suggested to be connected behind the oxygenator.

(2) Closely monitor consciousness and the vital signs of patients; accurately calculate the fluid inflow and outflow. Closely observe blood clotting within the cardiopulmonary bypass circuit, respond effectively to any alarms, and ensure that the machine is operating properly. Assess the electrolyte and acid-base balance in the internal environment through blood gas analysis every 4 hours. The replacement liquid should be prepared freshly and labeled clearly under strict sterile conditions.

3 Postoperative Care
(1) Monitor blood routine, liver and kidney function and coagulation function.
(2) Wipe the CRRT machine every 24 hours if continuous treatment is applied. Consumables and wasted liquid should be disposed in accordance with hospital requirements to avoid nosocomial infection.
VI. General Care

1 Monitoring

Patient vital signs should be continuously monitored, especially changes in consciousness, respiration rate and the oxygen saturation. Observe symptoms such as cough, sputum, chest tightness, dyspnea, and cyanosis. Monitor arterial blood gas analysis closely. Timely recognition of any deterioration to adjust strategies of oxygen therapy or to take urgent response measures. Pay attention to ventilator associated lung injury (VALI) when under high positive end-expiratory pressure (PEEP) and high-pressure support. Closely monitor changes in airway pressure, tidal volume and respiratory rate.

2 Aspiration Prevention

(1) Gastric retention monitor: perform continuous post-pyloric feeding with a nutrition pump to reduce gastroesophageal reflux. Evaluate gastric motility and gastric retention with ultrasound if possible. Patient with normal gastric emptying are not recommended for routine assessment;

(2) Evaluate gastric retention every 4 hours. Re-infuse the aspirate if the gastric residual volume is < 100 mL; otherwise, report to the attending physician;

(3) Aspiration prevention during patient transportation: before transportation, stop nasal feeding, aspirate the gastric residues and connect the gastric tube to a negative pressure bag. During transportation, raise the patient’s head up to 30°;

(4) Aspiration prevention during HFNC: Check the humidifier every 4 hours to avoid excessive or insufficient humidification. Remove any water accumulated in the tubing promptly to prevent cough and aspiration caused by the accidental entry of condensation into the airway. Keep the position of the nasal cannula higher than the machine and tubes. Promptly remove condensation in the system.

3 Implement strategies to prevent catheter-related bloodstream infection and catheter-related urinary tract infection.

4 Prevent pressure-induced skin injuries, including device-related pressure-induced injuries, incontinence-associated dermatitis and medical adhesive-related skin injuries. Identify patients at a high risk with the Risk Assessment Scale and implement preventive strategies.

5 Assess all patients upon admission and when their clinical conditions change with the VTE risk assessment model to identify those who are at a high risk and implement preventive strategies. Monitor coagulation function, D-dimer levels and VTE-related clinical manifestations.

6 Assist eating for patients who are weak, short of breath or those with an obvious fluctuating oxygenation index. Intensify oxygenation index monitoring on these patients during meals. Provide enteral nutrition at early stages for those who are unable to eat by mouth. During each shift, adjust the enteral nutrition rate and quantity according to the tolerance of enteral nutrition.