Defective Oxygenation in ECMO

This information describes the defective oxygenation in ECMO and the precautions to be taken when determining and changing out the ECMO. In ECMO, unexpected oxygenation failure may occur due to long-term use of oxygenator and patient transfers. Usually, when PaO_2 at the outlet of the oxygenator is extremely low, the first thing to be considered would be the oxygenator itself, but the problem can be caused by something other than the oxygenator, so appropriate decisions must be made rather than the immediate change-out of the oxygenator.
In addition, daily management is necessary to prevent human error.
Please refer to the general management checklist at the end of this information.

1. When defective oxygenation of the oxygenator is suspected

Point The gas exchange capacity of the oxygenator must be properly evaluated to determine if it is normal. It is important to understand whether the oxygenator is defective, marginal or degraded, the patient's condition, and the characteristics of the oxygenator.

The following table should be used to make a comprehensive decision:

	Points to be checked	Points to be noted
Not attributable to oxygenator	Are there abnormalities in gas settings and supply lines?	Check lines after transfer
	Is there any deterioration of vital lung function?	Abnormalities in chest X-ray photo, etc.
	Is Hb or SvO_2 excessively low?	Also consider the reduced gas affinity
Attributable to oxygenator	Is there any reduction in the carbon dioxide removal capacity?	Increase of $PaCO_2$ at the oxygenator outlet
	Is there water condensation in the oxygenator?	Presence of water droplet in the oxygenator
	Are there thrombus formation in the oxygenator?	Black spots (clot formation) seen through the oxygenator
	Is there plasma leakage?	Bubble coming from the oxygenator gas outlet.

If the cause cannot be identified even with the above table, oxygen transfer can be evaluated by simply calculating the amount of oxygen transfer and comparing it with the reference value in the instruction for use.

(Oxygen content at oxygenator outlet※ - Oxygen content at oxygenator inlet※) × Blood flow rate (ml/ml) = Oxygen transfer (ml/min)

※Oxygen content = 1.34 × Hemoglobin concentration (g/dL) × Oxygen saturation (%) / 100
(Blood dissolved oxygen is disregarded)

If the value is considerably lower than the reference value, the need for oxygenator change-out arises.

Caution!
Since the venous line has a strong negative pressure, blood sampling is dangerous because there is a risk of air entrainment.

What is water condensation phenomenon?

Condensation mainly occurs on the hollow fiber outlet end surface when gas insufflated through the hollow fiber membrane is cooled by the housing near the oxygenator outlet and by the outside air, as water vapor migrates from the blood. This phenomenon results in a decrease in membrane area and an increase in gas flow path resistance.

If the gas exchange capacity decreases due to this phenomenon, there is also a method to restore the gas exchange capacity by performing an oxygen gas flush as needed to blow off the condensed water. Other methods include warming the area around the oxygenator with a heater.

※When flushing gas more than the recommendations in the instruction for use, it is necessary to pay close attention not to leak air bubbles to the blood side by increasing the gas flow resistance. (Like when blood flow and blood pressure is low.)

What is plasma leakage?

It is the leakage of plasma components from the micropore of the porous membrane used in membrane oxygenators due to denaturation of the patient's blood or prolonged use. When plasma leakage occurs, attention must be paid to the decrease in carbon dioxide removal and oxygenation capacity and changing out of the oxygenator must be considered.

2. In the event of defective oxygenation of the oxygenator

Point Train on a regular basis to perform a prompt oxygenator or tubing set change-out. Also, confirm the location of items and devices such as tubing sets in case of emergency change-outs.

In the event of an unacceptable decrease in oxygenation capacity caused by the oxygenator, the oxygenator or the entire tubing set must be changed out. Please discuss with the surgeon before the change-out. Change-out procedures will not be mentioned but be sure to use a backup device or other means for priming to ensure adequate air elimination. Also, during change-out, pay attention to the hemodynamics and ACT, and make sure that the change-out procedure considers includes consideration the personnel and time required for the change-out.

Checklist for Preventing Defective Oxygenation

1）Check before initiating ECMO
- The gas tube is connected to the gas inlet port of the oxygenator.
- The gas tube is connected to the oxygen flow meter.
- The oxygen actually flows.
- FiO_2 is appropriate.

2）Check immediately after the initiation of ECMO
- The color of the blood in the arterial line.
- The value of blood gas or continuous gas monitor.
- The arterial blood flow is obtained.
- Reconfirm the gas flow rate and oxygen concentration.

3）Check during ECMO
- Blood gas or continuous gas monitor values at regular intervals.
- Blood gas should be checked not only at regular intervals, but also after transferring the patient or changing the patient's position.
- No blood clots are visible inside the oxygenator.
- No water condensation or plasma leakage.

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