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Preserving ECMO Cannulae Patency

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Abstract: Extracorporeal membrane oxygenation (ECMO) is often managed using minimal anticoagulation. This can make the circuitry susceptible to thrombosis. The ECMO cannula may be particularly vulnerable to thrombosis if flow is interrupted for an undetermined but prolonged period of time. Therefore, under conditions where cannula blood flow stasis may be prolonged and flashing, the cannulae is not an option (e.g., air in circuit) it is imperative to have an emergency plan available, which can be rapidly implemented that will provide a means of cannula patency preservation. The following outlines a system to preserve cannula patency in these instances.
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OVERVIEW

The use of adult extracorporeal membrane oxygenation (ECMO) has markedly expanded during the last decade (1). This corresponds with improvements in both ECMO console technology (hardware) and associated disposable components (oxygenator, centrifugal pump, and cannulae) that have simplified the technology (2). This new era has seen the role of ECMO amplified to a variety of clinical applications and novel hybrid cannulation configurations (3,4).

Despite these advances, ECMO complications remain common—including the most prevalent mechanical complication, clots in extracorporeal circuit (ECC). Nearly 20% of all ECMO circuits develop visible clots in them (5). The ECC can be particularly vulnerable to thrombosis if flow is interrupted for an undetermined but prolonged period of time. Under controlled situations of weaning and trialing off, it is common to perform periodic resumption of flow ("flashing") through the cannulae to prevent thrombosis and assure the preservation of cannulae patency (6). However, under crisis conditions where cannulae blood flow stasis may be prolonged and flashing the cannulae is not an option (e.g., air in circuit), it is imperative to have an emergency plan available, which can be rapidly implemented to provide a means of cannulae patency preservation. Cannulae patency is crucial for reinitiating immediate ECMO after the circuit has been assessed or a new circuit is reconnected to the cannulas. In the setting of ECMO staffing models in which the perfusionist may not be present in-house, it is especially important to establish an emergency protocol. The following outlines a system to preserve cannula patency in these instances.

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DESCRIPTION

The following describes the contents of the cannulae preservation kit and the protocol for implementing this cannulae preservation technique.

Cannulae Preservation Kit

A bedside kit that includes sodium chloride (NaCl), IV set, heparin, luer tubing connector, sterile scalpel (or scissors), sterile syringe, 70% isopropyl alcohol pad, and a pressure infusion bag (Table 1). This kit should accompany the ECMO circuit or ECMO cart for rapid deployment if necessary.

Initiating the Protocol

The protocol is outlined in Figure 1. Briefly, using the cannulae preservation kit, draw up 1 mL (1,000 I.U.) of heparin and add it to 1 L .9 NaCl. Spike and prime the IV

Table 1. Cannula preservation kit contents.

Heparin 10 mL 1,000 units/mL
NaCl (9%) 1,000 mL bag
Tubing connector 3/8 × 3/8 w/luer
IV set
Syringe 10 mL
Sterile scalpel or scissor
Pressure infusion bag

set. The first step is to double clamp the arterial and venous line. Step 2 requires swabbing the area between the clamps using the 70% isopropyl alcohol pad from the kit and allowing it to air-dry (approximately 30 seconds). Now, using sterile scalpel or scissors from the kit, cut the tubing between the clamps carefully, maintaining aseptic technique. Third, add 3/8 straight luer connector to venous line and attach the IV tubing from the heparinized NaCl bag to the luer on the connector. Step 4 is to open IV set to slowly fill the connector and making an air-free connection with the arterial tubing. Step 4 also includes adding a pressure infusion bag and setting to approximately 150 mmHg or to a pressure greater than the systolic pressure of the patient. Flushing the cannulae is now possible by removing one clamp at a time and allowing heparnized saline to flush through the cannulae. Flushing should be performed every 20 minutes until a new circuit is attached or the cannulae removed. Flushing more frequently should be assessed if the aPTT or ACT is not at targeted levels.

DISCUSSION

ECMO programs have developed with a variety of staffing models (7,8). Models may not include perfusionists at the bedside or even in-house, yet rely on perfusionists

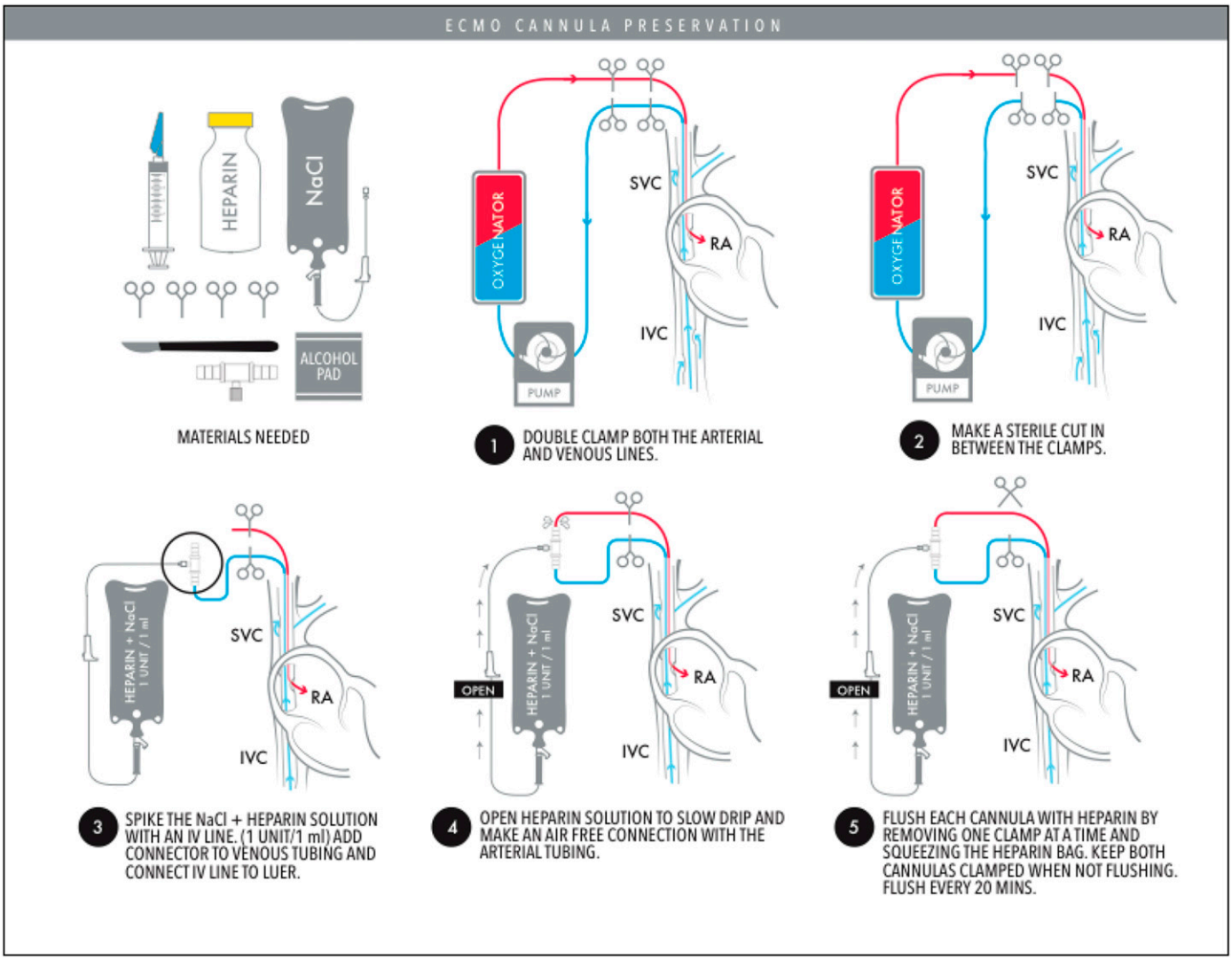

Figure 1. Protocol for cannula patency preservation. SVC, superior vena cava; IVC, inferior vena cava; RA, right atrium.

for setup, priming, initiation, and significant ECMO circuit interventions. This is the setting of the development of this protocol, which emerged from an event that required the ECMO specialist to clamp-out the patient. With no arteriovenous (A-V) bridge in line to flash the cannulae and unable to safely go back on ECMO, the specialist contacted the on-call perfusionist. Unfortunately, within the 30-minute response time, the cannula had already clotted. This experience may be more common than reported as cannula appears to be particularly susceptible to thrombosis and can significantly complicate ECMO therapy (9–13). Therefore, avoidance of cannula thrombosis is important while resolving flow cessation and waiting for the perfusionist to arrive. This protocol can also be applied in the non-emergent setting of trialing off ECMO. The ELSO guidelines (14) maintain that:

"If the trial off is successful, circuit lines can be cut and access cannulae "locked" with heparinized saline awaiting decannulation. If the trial off is successful, but precarious, the circuit can be cut away and access cannulaes left in place in case the patient needs to be returned it to ECLS support with a new circuit. In this circumstance the usual practice is to infuse low dose heparinized saline into the cannulae reassess frequently. Access cannulas can be left in place 24 hours or more."

Cannula thrombosis in the setting of minimally anticoagulated ECMO is a significant risk. Cannula preservation kits and ECMO circuits purposely designed to mitigate these risks should be considered. It is recognized that alternative techniques could be used to preserve cannulae than is presented here. For example, ECMO circuits using arteriovenous (A-V) bridges could also be useful in maintaining cannulae patency in emergent settings. The important point here is having a well-developed cannulae patency preservation protocol with regular ECMO specialist competency training. This will help avoid the complications associated with flow cessation and cannula thrombosis.

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