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Safety of intensivist-led bedside decannulation of internal jugular bi-caval dual-lumen veno-venous extracorporeal membrane oxygenation cannulas and report of technique

Aaron Heller[1], John Dollerschell[1], Joshua Burk[2], Haley Haines[1], Jonathan Kozinn[1]

[1]Department of Anesthesiology, Perioperative Medicine, Critical Care and Pain Medicine, University of Missouri Kansas City, USA
[2]Department of General Surgery, University of Missouri Kansas City, USA

Abstract

Background: In the past decade, the rate and utilization of veno-venous extracorporeal membrane oxygenation (VV-ECMO) has increased dramatically. A single catheter technique has recently come into favour for providing VV-ECMO. Although it has been shown that intensivists can safely place these catheters, the safety of decannulation by intensivists has not been reported in the literature.

Objective: We describe a technique for safely decannulating the Avalon Elite VV-ECMO catheter at the bedside and assess the safety of this technique, as compared with the standard technique of decannulation in the operating room by a surgeon.

Methods: This was a retrospective cohort design conducted at a tertiary care cardiovascular intensive care unit at an academic medical centre. All patients who underwent VV-ECMO from 2009 to 2014 were included in the study except for those who had been decannulated for withdrawal of care. Complication rates from decannulation were compared between patients who were decannulated by surgeons in the operating room and those decannulated by intensivists in the intensive care unit (ICU).

Results: Twenty-eight patients were included in this study, of whom twenty-three patients (82%) were decannulated by intensivists, board certified in Critical Care Medicine through the American Board of Anesthesiology, while five (18%) the patients were decannulated by a surgeon. There was no significant difference in the complications rates between the surgeons (0) and intensivists (1) ($P = 1.00$). There were no major complications requiring operative intervention associated with decannulation identified in this study.

Conclusions: It is safe for intensivists to decannulate the Avalon Elite VV-ECMO cannula in the ICU using our purse-string suture technique. Performing these decannulations at the bedside compared to operating room may have positive clinical ramifications that include improved patient safety, timely patient care and reduced operating room costs.

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Key words: extracorporeal membrane oxygenation, ECMO; decannulation; safety; intensive care unit

Over the past decade, the use of veno-venous extracorporeal membrane oxygenation (VV-ECMO) for severe respiratory failure has increased from 11.4 cases per million in 2006 to 60.9 cases per million in 2011 [1]. This represents a substantial increase of 433%. Two principle reasons for this, is the increased utilization of ECMO as a rescue therapy for severe respiratory failure [2–4] and the improved equipment (membrane oxygenators, centrifugal pumps and bi-caval dual-lumen cannulas) to deliver this therapy.

Initially, the most common technique for initiating ECMO was a femoral-femoral cannulation which required access to both femoral veins for the placement of at least two cannulas, and, occasionally, a third into the internal jugular (IJ) vein. If an IJ cannula was placed, its position was with the tip in the superior vena cava in order to provide adequate upper-body drainage [5]. The disadvantages of this approach included the following: infection risk; line-care; immobilization; as well as the need to keep the patient supine.

In light of these disadvantages, a single-cannula technique utilizing the internal jugular vein has come into favour [6]. The proprietary Avalon Elite Cannula incorporates two lumens, an outflow and an inflow, and when placed correctly, the outflow tract is positioned in the right atrium and the inflow in the vena cava with its openings at the superior and inferior vena cava to facilitate drainage.

Athoughhere have been several review articles demonstrating the safety of non-surgeons placing patients on ECMO [6, 7], little has been written about decannulation. In fact, decannulation and decannulation techniques are usually only a passing reference in journal articles on ECMO. Decannulating at the bedside in an intensive care unit has the potential to pose a higher risk compared with that of a surgeon decannulating in the operating room. Moreover, it is a different procedure compared with placing the cannula, as there are fewer support staff, less access to equipment while the patients are fully anticoagulated. We hypothesize that decannulation can be safely undertaken by intensivists trained in our described technique and, furthermore, this can be safely accomplished in the ICU instead of the operating room.

DECANNULATION TECHNIQUE

Prior to decannulation, patients must have had demonstrated their ability to be fully supported by conventional mechanical ventilation, unless decannulation was for withdrawal of care. The method of transition from VV-ECMO to mechanical ventilation was at the discretion of the intensivist, with the exception that prior to decannulation the oxygen/air mixture flow had been turned off for twelve to twenty-four hours.

Approximately four hours prior to decannulation, heparin is stopped and the prothrombin is checked. Other anticoagulants, if needed, were stopped and reversed. Protocols for stopping and reversing heparin vary at different institutions. It is also common practice to continue heparin up to the point of decannulation and then reverse anticoagulation with protamine sulfate. At our institution, we hold administering heparin and do not give protamine sulfate. Following confirmation of adequate anticoagulation reversal, sedation is increased and a neuromuscular blockade may

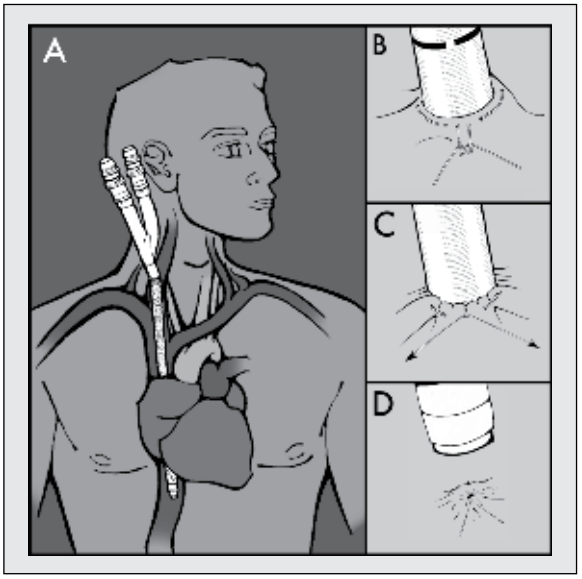

Figure 1. Panel A depicts the placement of the Avalon Elite ECMO cannula in place in the right internal jugular vein. **Panel B** is focused on the cannula site at the skin and depicts the initial purse string suture throws. **Panel C** demonstrates the tightening of the suture with a surgeon's knot while the cannula is being removed. **Panel D** depicts the complete removal of the cannula and closure of the skin with the purse string suture. The knot is finished and the tails are cut

be administered at the discretion of the intensivist. For decannulation, the patient is placed in a slight Trendelenburg position, the cannula and surrounding tissue are prepped with chlorhexidine-gluconate and then the patient is draped wide. A sterile technique is followed throughout the entirety of the procedure. Subsequently, a purse-string throw with 0-silk suture is placed around the cannula (Fig. 1), and then the centripetal pump is turned off and the cannula lines are clamped. Following this, the purse-string suture is tightened down and tied, while simultaneously, an assistant removes the cannula. If additional haemostasis is required, additional sutures are placed. Direct pressure is held for fifteen minutes and a dry sterile dressing is applied. The sutures are left in place until wound healing is adequate to allow safe removal.

METHODS

To assess the safety of this technique at the bedside we conducted a retrospective cohort study approved by the Institutional Review Board of our hospital. All patients who undergo ECMO at our institution are entered prospectively in an institutional database. From this database, the records of all patients who underwent VV-ECMO from 2009 through 2014 were examined and sorted according to who had performed the decannulation, an intensivist or a surgeon. Those patients who had undergone decannulation as part of a planned withdrawal of care were excluded from this study.

Table 1. Demographics of VV-ECMO population decannulated by intensivists and surgeons. Data given as mean ± SD unless otherwise indicated

Variable	Intensivist (n = 23)	Surgeon (n = 5)	*P*-value
Age (years)	43.7 ± 13.0	42.6 ± 10.5	0.854
Female gender (%)	52.2	40.0	1.00
BMI (kg m^{-2})	36.5 ± 12.0	33.1 ± 13.3	0.625
Days on VV-ECMO	14.6 ± 11.8	12.6 ± 7.0	0.632
Percent change in haemoglobin	1.1 ± 9.6	−2.2 ± 12.9	0.610
Number of complications with decannulation	1	0	1.00

The demographic and ECMO data that were obtained from the medical record included the following: gender; age; days spent on VV-ECMO; haemoglobin before and after; associated blood loss; and any other noted complication with decannulation. A complication was defined as bleeding that required transfusion, or any event that required an additional procedure or operative intervention. Data on the haemoglobin trend was collected, as bleeding was expected to be the most common and serious risk associated with decannulation. Two reviewers independently reviewed each chart, and the data was collected on a standardized sheet. The results were compared, and if there were any discrepancies, a third reviewer would review the chart to reconcile the differences.

The complication rates between decannulations by surgeons and intensivists were compared using the two-tailed Fisher exact test. Statistical analysis was performed using SAS 9.4 (SAS Institute, Cary, USA).

RESULTS

A total of 28 cases were included in this study. Intensivists decannulated 23 of these cases (82%) while a surgeon decannulated the remaining 5 cases (18%). The demographic data is shown in Table 1. There were no significant differences between the respective intensivist and surgeon cohort demographics for the following: female gender percentage (52.2 vs. 40.0, $P = 1.00$); mean age in years (43.7 ± 13.0 vs. 42.6 ± 10.5, $P = 0.854$); mean BMI (36.5 ± 12.0 vs. 33.1 ± 13.3, $P = 0.625$); mean number of days on ECMO (14.6 ± 11.8 vs. 12.6 ± 7.0, $P = 0.632$); or mean percent change in haemoglobin with decannulation (1.1 ± 9.6 vs. −2.2 ± 12.9, $P = 0.610$). Although there was one observed minor complication during decannulation by an intensivist, there was no statistically significant difference in the complication rate between the two groups ($P = 1.00$).

DISCUSSION

Our study demonstrates that an appropriately trained intensivist can safely decannulate a VV-ECMO dual-lumen cannula by utilizing our purse-string suture technique in the ICU.

The only complication found was a peripherally inserted central catheter (PICC) line that became dislodged during decannulation. In this case, the complication was immediately recognized and the PICC was withdrawn so that the purse-string suture could be safely tied down. There was one case in which a cardiothoracic surgeon was requested for backup during decannulation as the cannula was difficult to remove. The surgeon also found that more force than expected was required to remove the cannula. It was later presumed that this difficulty was due to the extremely muscular physique of this particular patient. In neither of the above situations did any major harm come to the patient.

The potential advantage of intensivist decannulation in the ICU is two-fold. The first is that a visit to the operating room is avoided. The risk associated with transport of patients on ECMO is high [8, 9]. In one study, up to a third of intra-hospital transports of critically ill patients resulted in an adverse event [8]. Moreover, moving a patient on ECMO from an ICU bed to an operating room table is also fraught with risk. The second advantage concerns cost and convenience. By performing the decannulation in the ICU, the intensivist is not dependent on the schedule of the operating room or the availability of a surgeon. This may allow for earlier decannulation and a reduction in the risk of prolonged cannulation. In addition, time in the operating room is expensive and requires a significant staff burden (surgeon, anaesthesiologist, scrub tech, nurse circulator, ICU nurse, etc.) compared to ICU decannulation. Operating room costs are difficult to estimate but have been reported to be between $29 and $80 a minute [10]. This is likely an underestimate of the cost in the cardiovascular OR per minute. It may be proposed that it is likely that decannulation performed in the ICU has a significant cost reduction compared decannulation in the operating room, although it would require further investigation to confirm this.

The weaknesses of this study include its retrospective nature and the small sample size. Nonetheless, in our institution we plan on continuing to use the above-mentioned technique and will monitor for associated complications. It must be noted that in our facility there is a cardiovascular

surgeon available at all times to assist with any significant complications if needed.

CONCLUSION

It is safe for intensivists to decannulate VV-ECMO cannulas in the ICU using our purse-string suture technique. Performing these decannulations at the bedside compared to operating room has positive clinical ramifications that include improved patient safety, timely patient care and reduced operating room cost. We do recommend consulting a cardiovascular surgeon for back-up support if there is any concern about a complicated decannulation, or significant bleeding is encountered.

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References:

1. *Sauer CM, Yuh DD, Bonde P:* Extracorporeal membrane oxygenation use has increased 433% in adults in the United States from 2006 to 2011. ASAIO J 2015; 61: 31–6. doi: 10.1097/MAT.0000000000000160.
2. *Noah MA, Peek GJ, Finney SJ et al.:* Referral to an extracorporeal membrane oxygenation center and mortality among patients with severe 2009 influenza A (H1N1). JAMA 2011; 306: 1659–1668. doi: 10.1001/jama.2011.1471.
3. *Pham T, Combes A, Rozé H et al.:* Extracorporeal membrane oxygenation for pandemic influenza A (H1N1)-induced acute respiratory distress syndrome: a cohort study and propensity-matched analysis. Am J Respir Crit Care Med 2013; 187: 276–285. doi: 10.1164/rccm.201205-0815OC.
4. *Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators, Davies A, Jones D, Bailey M et al.:* Extracorporeal membrane oxygenation for 2009 Influenza A (H1N1) acute respiratory distress syndrome. JAMA 2009; 302: 1888–1895. doi: 10.1001/jama.2009.1535.
5. *Annich G, Lynch W, MacLaren G, Wilson J, Bartlett R: ECMO*: Extracorporeal cardiopulmonary support in critical care. 4th ed. ELSO, Plymouth 2012.
6. *Javidfar J, Brodie D, Wang D et al.:* Use of bicaval dual-lumen catheter for adult venovenous extracorporeal membrane oxygenation. Ann Thorac Surg 2011; 91: 1763–1769. doi: 10.1016/j.athoracsur.2011.03.002.
7. *Conrad SA, Grier LR, Scott LK, Green R, Jordan M:* Percutaneous cannulation for extracorporeal membrane oxygenation by intensivists: a retrospective single-institution case series. Crit Care Med 2015; 43: 1010–1015. doi: 10.1097/CCM.0000000000000883.
8. *Smith I, Fleming S, Cernaianu A:* Mishaps during transport from the intensive care unit. Crit Care Med 1990; 18: 278–281.
9. *Venkategowda PM, Rao SM, Mutkule DP, Taggu AN:* Unexpected events occurring during the intra-hospital transport of critically ill ICU patients. Indian J Crit Care Med 2014; 18: 354–357. doi: 10.4103/0972-5229.133880.
10. *Macario A:* What does one minute of operating room time cost? J Clin Anesth 2010; 22: 233–236. doi: 10.1016/j.jclinane.2010.02.003.

Corresponding author:
Aaron Heller
Department of Anaesthesiology
Perioperative Medicine
Critical Care and Pain Medicine
University of Missouri Kansas City, USA
e-mail: helleran@umkc.edu

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