

Advance in ECMO Practice

Saturday 27 April, 2024 09.00 - 15.10

Simulator Lab. Floor 3th, Rama. School of Nursing building Ramathibodi Hospital

PROGRAM

		opeaner
09.00 - 09.10	Openning	
	Assoc. Prof. Montien Ngodngamtaweesuk	
09.10 - 09.30	ECMO Cannulation practice update	
10	Assoc. Prof. Piya Samankatiwat	
09.30 - 09.50	ECMO circuit and monitoring equipment	Assoc Prof Piva Saman
	Apirit Chamnanya	ASSOC. FIOI. Flya Salilali
10.00 - 12.00	Hands on Station – Cannulation ECMO	
	Assoc. Prof. Piya Samankatiwat	
	Assist. Prof. Narongrit Kantathut	
12.00 - 13.00	Lunch	Assist Prof Narongrit Kar
13.00 - 15.00	Hands on Station – ECMO Guideline	- Assist. Froi. Natolight Kar
	Assoc. Prof. Piya Samankatiwat	7000
	Assist. Prof. Narongrit Kantathut	
15.00 - 15.10	Wrap up and Closing	
	MA	Apirit Chamnanya

We gratefully thank to Perfusionist team

Speaker



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Cannulation for ECHO: Piya samankat

CANNULATION FOR ECMO: WHICH SITE, WHICH DEVICE FOR WHICH PATIENT AND PATIENT SELECTION

PIYA SAMANKATIWAT DEPARTMENT OF SURGERY RAMATHIBODI HOSPITAL

OBJECTIVES OF THIS TOPIC WHICH SITE, WHICH DEVICE FOR WHICH PATIENT AND PATIENT SELECTION

- To select appropriate cannulation size and site
- To understand correct cannulation technique
- To recognise complications of cannulation

Important messages

Cannulation is dangerous

• How to cannulate safely?

44-year-old male – ARDS caused by COVID-19

BW 90 kg – What is the required cardiac output?

- ECMO configuration?
- Cannulation site?
- Cannulation technique?
- Size of cannulae

54-year-old female – CAD S/P CABG with postoperative low cardiac output

BW 60 kg – What is required cardiac output?

- ECMO configuration?
- Cannulation site?
- Cannulation technique?
- Size of cannulae

7-month-old male baby – dTGA-VSD postoperative ASO and VSD closure

BW 5.5 kg – What is the required cardiac output?

- ECMO configuration?
- Cannulation site?
- Cannulation technique?
- Size of cannulae

1-day-old baby – PPHN

BW 3.2 kg – What is required cardiac output?

- ECMO configuration?
- Cannulation site?
- Cannulation technique?
- Size of cannulae

ECMO INDICATIONS

VA-ECMO

- After cardiac surgery unable to wean off CPB
- Refractory cardiogenic shock
- Decompensated chronic CHF
- Heart failure after Heart transplantation
- Bridge to recovery, MCS, transplant
- Persistent pulmonary arterial hypertension of the neonate
- Congenital diaphragmatic hernia
- Sepsis
- ECPR

VV-ECMO

- Respiratory distress syndrome
- Acute respiratory insufficiency
 - in pts. receiving at least 48 hours of optimal conventional ventilatory therapy with no improvement in pulmonary function
 - due to a viral or bacterial pneumonia, aspiration pneumonia, respiratory burns
 - diagnosis must be reversible within 14 days

INITIATION AND MAINTENANCE OF ECMO

- Decision to start ECMO and team alert
- Circuit setup: "priming"
- Heparinisation
- Cannulation- selection of cannulae and site
- Initiation of ECMO
- Maintenance of ECMO
 - Flow:
 - Paediatric 100-150 ml/kg/min
 - Adult 80 100% cardiac output
 - Monitoring
 - On-the-run problem solving or trouble shooting
- Weaning off ECMO and Discontinuation
- Decannulation
- After ECMO care





CONCERN LIFE SUPPORT OR CANING

Guidelines

ELSO Guidelines for Adult and Pediatric Extracorporeal Membrane Oxygenation Circuits

EVAN F. GAJKOWSKI^D,* GUILLERMO HERRERA,† LAURA HATTON,‡ MARTA VELIA ANTONINI^D,§,¶ LEEN VERCAEMST,∥ ELAINE COOLEY,#

REVIEWERS: ELIZABETH MOORE,** BISHOY ZAKHARY, ++ MARK OGINO, ++ GILES PEEK, S AND THOMAS MUELLER, ¶ ¶

ECMO CANNULAE DESIGN

1	Tip	End hole	Number of hole rows
	Return cannulae (arterial, re	infusion)	
2	1. Blunt	Yes	None
	2. Gun tip	Yes	1
	3. Semi lighthouse	Yes	2
	4. Lighthouse (<40 mm)	Yes	≥3
	Drainage cannulae (venous)		
	4. Lighthouse (<40 mm)	Yes	≥3
	5. Multistage	Yes	≥4
	6. Multistage interrupted	Yes	≥3 x 2
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ECMO cannulae



VENOUS ECMO CANNULAE

Bio-Medicus Venous Cannulae

Bio-Medicus Venous Cannulae Tip Multiple Wholes



http://www.maquet.com/int/products/av



Dual-lumen cannula for VV ECMO

Cannulation for ECHO: Piya samankatiwat,MD. (27/04/67)

alon-elite/

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DOUBLE LUMEN CANNULA FOR VV





CANNULATION: SELECTION OF SIZE AND SITE

• Cannulae must be large enough to provide adequate cardiac index.

SIZE DOES MATTER

- Blood flow needs to be sufficient in quantity
- Efficiency in terms of where blood is drained and returned.

The choice of the cannula is guided by

- aimed degree of support
- size and condition of the vessel
- patient size
- possible site of placement
- type of insertion procedure
- desired location of blood drainage/ return

VA-ECMO: SELECTION OF ARTERIAL CANNULA SIZE

Flow (ml/minute)	Size (Fr)	External diameter (mm)
0 to 400	8	2.66
400-700	10	3.33
700-1200	12	4
1200-1700	14	4.66
1700-2000	15	5
2000-2500	17	5.66
2500-3500	19	6.33
>3500	21	EITEN 7

Chauhan S, Subin S. Extracorporeal membrane oxygenation - An anesthesiologist's perspective - Part II: Climitualianted tettorrival-menicider atticer. (Anaesth 2012;15:69-82 Slide 20/66 Chauhan S, Subin S. Extracorporeal membrane oxygenation - An anesthesiologist's perspective - Part II: Clinical and technical consideration. Ann Card Anaesth 2012;15:69-82

SELECTION OF VENOUS CANNULA SIZE

Flow (ml/minute)	Size (Fr)	External diameter (mm)
0 to 350	8	2.66
350-600	10	3.33
600-1000	12	4
1000-1400	14	4.66
750-1000	15	5
1000-1500	17	5.66
1500-23000	19	6.33
2000-2500	21	7
25000-5000	23	7.66
3000-3600<	25	8.33
3600-4500	DB 27	9
4500<	H 29 DI H	9.66

SELECTION OF SIZE ACCORDING TO WEIGHT

Weight (Kg)	Venous cannula	Arterial cannula			
2-4	8-14	8-10			
5-15	15-19	12-15			
16-20	19-21	15-17			
21-35	21-23	17-19			
35-60	23	19-21			
>60	ATHIDDD HDSP	21			

LOCATIONS FOR CANNULATION

Туре	Arterial	Venous
VA Post cardiotomy ECMO Central Cannulation	Aorta	Right atrium
Peripheral Cannulation	-Right common carotid a. <mark>(Body weight < 15 kg [30])</mark> -Femoral a.	-Internal jugular v. <mark>(Body weight < 15 kg [30])</mark> -Femoral v.
VA non-cardiac surgical ECMO, ECPR	As peripheral	As peripheral
VV ECMO (double lumen cannula)	-	Internal jugular v.
VV ECMO late childhood and adult	- ITAL	-Femoral-to-internal jugular v.
	ATHIBDDI HDEP	-Bilateral temoral veins

•••• AIS 4G

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1 76% 🗖

Timer

CANNULATION FOR ECPR

 Site - Femoral vessels [easy approach and ongoing CPR] Alternatives - jugulo-femoral, femoro-subclavian or jugulo-subclavian routes.

Central cannulation outside the operating theatre??

Technique – percutaneous or surgical cut-down



TECHNIQUES

- Percutaneous (Seldinger)
 - dilators provided separately apart from the cannulae → very important.
- Semi-open dilate and insert under direct vision
- Open- surgical cutdown



ESSENTIAL EQUIPMENT

- Cannula arterial and venous
- Vascular clamps
- Vessel loops
- Polypropylene suture
- Silastic membrane (for central Cannulation of ECMO if needed)
- Heparin 100 Units/kg/dose (1 mg/kg/dose)
- Wound sealant





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VA ECMO CANNULATION

Cannulation for ECHO: Piya samankatiwat, MD. (27/04/67)

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ANATOMY OF THE NECK



Cannulation for ECHO: Piya sama

HOW I DO IT? NECK CANNULATION



ECMO CANNULATION FOR SMALL BABIES









AXILLARY CANNULATION



ANATOMY OF THE GROIN





SPECIAL CONSIDERATIONS IN PERIPHERAL VA-ECMO CANNULATION

- Neck (cervical) cannulation
 - Cerebral blood flow on the side of cannulation depends on circle of Willis.

- Groin (femoral) cannulation
 - Limb ischaemia can occur up to 30 %, hence a distal perfusion cannula is recommended to prevent limb loss.

FEMORAL CANNULATION – DISTAL PERFUSION CANNULA





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Table 6.1 Cannulation insertion checklist

Sign in

Wrist band check and patient confirmed Red blood cells: 2 units available Platelets: >100,000 or plan in place C-arm in place and compatible X-ray table and positioning OK **Time out** Name and role of each person in the room Procedure explained Facemasks Goggles/visors Lead aprons (if using fluoroscopy) Cannula size agreed and available ECMO circuit ready Back-up plan for failed insertion Monitoring, including: invasive blood pressure, central venous pressure and end-tidal CO₂ Large venous access secured Antibiotics Anticoagulation Any concerns? Sign out Dressing in place All lines are secured Instrument count correct Guidewires and sharps disposed safely Issues/notes

TIPS AND TRICKS

- Prepare 3 guide wires at time
 - 2 large guide wires for FA and FV
 - 1 smaller wire for distal perfusion cannula
- Insert 3 guide wires consecutively
- Gradually dilate the vessel and insert the cannula
- Importantly, do not over dilate the vessels and skin
- Start at the FV \rightarrow FA \rightarrow distal perfusion cannula
- Proper site of the tip
 - FA cannula must be in the descending aorta
 - FV cannula in RA
- Determine the position of the tips using CXR and echocardiography



Original direction of the guide-wire insertion



Figure 6.3 Angle of cannulation to avoid a kink in the wires.













De-exygenated Blood

VV ECMO CANNULATION

ECMO CONFIGURATION AND CANNULATION

VV ECMO cannulation

- Mostly peripheral cannulation
- Types of cannula
- 1. Two venous cannulae
 - SVC-femoral venous cannulation
 - Bifemoral venous cannulation
- 2. Dual-lumen venous cannula
 - Neck cannulation (especially for small baby)
 - Groin cannulation (via femoral vein)

VV ECMO CANNULA



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DOUBLE-LUMEN CANNULATION

- Ultrasound guided
- Seldinger technique
- Drainage lumen is directed to the IVC.
- Return lumen is directed to the tricuspid valve.

Catheter Dimensions



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Description		Connector Size		xdy Dia me	#r	Incertable	o Longik	Prosimal Body to b	insertable dusion Part	SIVE to linit Lans	kcion Port gili	Inflution Length (L	Port to Tip red Longth (SVC 10-11	p Length.	Ļ	ad Diamet	er.
	Units	in	- Fr	riture	- in -	089	in -	600	in	-011	in -	000	in	65	in i	Fr.	nen	in .
		-																
Description	Order																	
Size	Code																	
13 Fr.	10013	1/4	- 13	4.3	0.17	- 31	4.3	8	3.2	1.7	0.7	2.8	1.1	4.5	1.8	- 11	3.7	0.35
16 Fr.	10016	1/4	16	5.3	0.21	- 34	5.5	10	3.9	31	1.2	4	1.6	7.1	2.8	14	4.7	0.19
19 Fr.	10019	- 1/4	- 59	6.4	0.25	31	8.3	15	6	43	- 1.7	5.7	- 3:4	10	4	- 16 -	- 5.3	0.21
20 R.	10020	3/8	- 20	6.6	0.26	11	12.2	22	8.5	- 5.3	2.1	9.4	1.7	- 34.7	5.8	-17	5.7	0.22
23 Fr.	10023	- 2/0	23	7.7	0.3	- 34	12.2	22	0.5	53	2.1	2.4	3.7	34.7	5.6	20	6.7	0.25
27 Pr.	10027	3/8	- 27	- 9	0.35	31	12.2	- 22	8.5	5.3	2.1	3.4	<u>_17</u>	34.7	5.8	- 24	8	0.31
85 Fr.	10031	3/9	33	\$3.8	0.41	- 84 ->	52.2	22	8.5	5.8	2.1	9.4	1.7	34.2	5.8	- 22	9	0.35

Tolerances may vary, specifications for reference use only and are subject to change.

mod

SELECTION OF DUAL-LUMEN CANNULA (AVALON ELITE[®])

Size	Weight guide	Flow Rate (I/min)						
(Fr)	(kg)	Median	Range					
23	15-20	2.22	1.86 - 3.30					
27	20-65	3.32	2.20 - 4.67					
31	>65	4.10	2.28 - 8.16					

SMALL-SIZE CANNULA

- Available only 2 sizes
 - 13 Fr
 - 16 Fr
 - 19 Fr



FEMORAL-TO-RIGHT INTERNAL JUGULAR VV ECMO

- Drainage cannula (deoxygenated blood) is inserted at femoral vein.
- Oxygenated blood returns via the right internal jugular vein.
- Seldinger technique under ultrasound guide.
- Echo. to check position and distance between the tips of cannulae. (5-10 cm apart)
- Drainage (outflow) cannula is in intra-hepatic IVC.
- Inflow cannula is in the right atrium.





FEMORAL-TO-FEMORAL VV ECMO

- Drainage cannula is placed in one femoral vein.
- Return cannula is in the other femoral vein and its tip is higher than the other one into the RA.



IMMEDIATE AFTER CANNULATION CARE

- Check the position
 - Intraoperation: C-arm fluoroscopy
 - In the ICU: chest x-ray and abdominal x-ray
 - Echocardiography
- Wound care: unnecessary, except bloody discharge
- Prophylactic antibiotics: uncertain
- Surveillance of
 - Blood stream infection
 - Limb perfusion

POST-CANNULATION CARE

- Wound care
- Infection prophylaxis
- Facing bleeding problem
- Fixation of cannulae

COMPLICATIONS

- Bleeding
- Infective complication
- CNS complications: embolism, infarction, bleeding
- Limb ischaemia
- Vascular injury
- Thrombo-embolism
- Pneumothorax



Anterior Superior Lac Spine

bleeding

44-year-old male – ARDS caused by COVID-19

BW 90 kg (BSI = 2.18) – What is required cardiac output? Calculate CO from CI (2.4 L/min/m²) = 2.18 x 2.4 = 5.3 L/min

- ECMO configuration?
 - VV ECMO
- Cannulation site?
 - Femoral v– Internal jugular v or bi-femoral v
- Cannulation technique?
 - Seldinger
- Cannulae's size
 - 29 Fr

54-year-old female – CAD S/P CABG with postoperative low cardiac output

BW 60 kg (BSI – 1.65) – What is required cardiac output? Calculate CO from CI (2.4 L/min/m²) = $1.65 \times 2.4 = 3.96$ L/min

- ECMO configuration?
 - VA -ECMO
- Cannulation site?
 - Preferred peripheral cannulation (Fem-Fem) to central cannulation
- Cannulation technique?
 - Seldinger or Semi-open
- Cannulae's size
 - Return (arterial) 21 and Drainage (venous) 23 or 25

7-month-old male baby – dTGA-VSD postoperative ASO and VSD closure unable to wean off CPB

BW 5.5 kg = – What is required cardiac output? Calculate CO from 150 ml/kg/min = 5.5 x 150 = 825 ml/min

- ECMO configuration?
 - VA-ECMO
- Cannulation site?
 - Central
- Cannulation technique?
 - Direct cannulation at the aorta and RA
- Cannulae's size
 - Arterial 10, venous 16

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1-day-old baby – PPHN

BW 3.2 kg = – What is required cardiac output?

Calculate CO from 150 ml/kg/min = 3.2 x 150 = 480 ml/min

- ECMO configuration?
 - VA-ECMO
- Cannulation site?
 - Cervical cannulation right common carotid artery and internal jugular vein
- Cannulation technique?
 - Neck Cutdown
- Cannulae's size
 - Arterial 10, venous 12



NENT DF

CONCLUSION

- ECMO cannulation is neither a safe nor straight-forward procedure
- Selection of a proper ECMO configuration, site of cannulation and suitable size of cannulation are crucial
- Majority of complications are preventable
- Early detection and management is the most significant measure

ECMO in the Adult Patient

CORE CRITICAL CARE

Alain Vuylsteke Daniel Brodie Alain Combes Jo-anne Fowles Giles Peek

CAMERINGE Medicine

REFERENCES

- ELSO GUIDELINES FOR ADULT AND PEDIATRIC ECMO CIRCUITS. DOI: 10.1097/MAT.00000000001630
- *Chapter 6 Cannulation and Decannulation in* Vuylsteke A, Brodie D, Combes A, Fowles J, Peek G: *ECMO in the Adult Patient*. Core Critical Care. Cambridge University Press; 2017:iv-iv.