



Complications liées aux canules d'ECMO



Alain Combes

Service de Réanimation

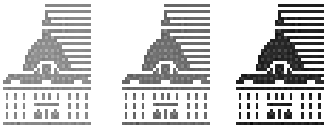
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The ECMO extracorporeal circuit

Centrifugal pump

Membrane oxygenator

Controller

Cannulas

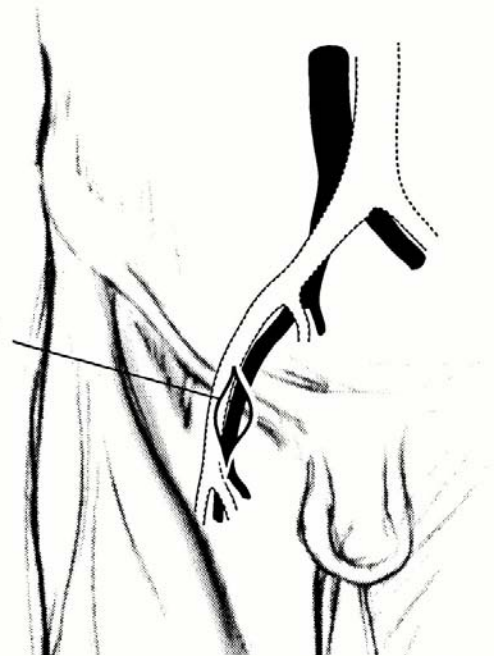
Tubing



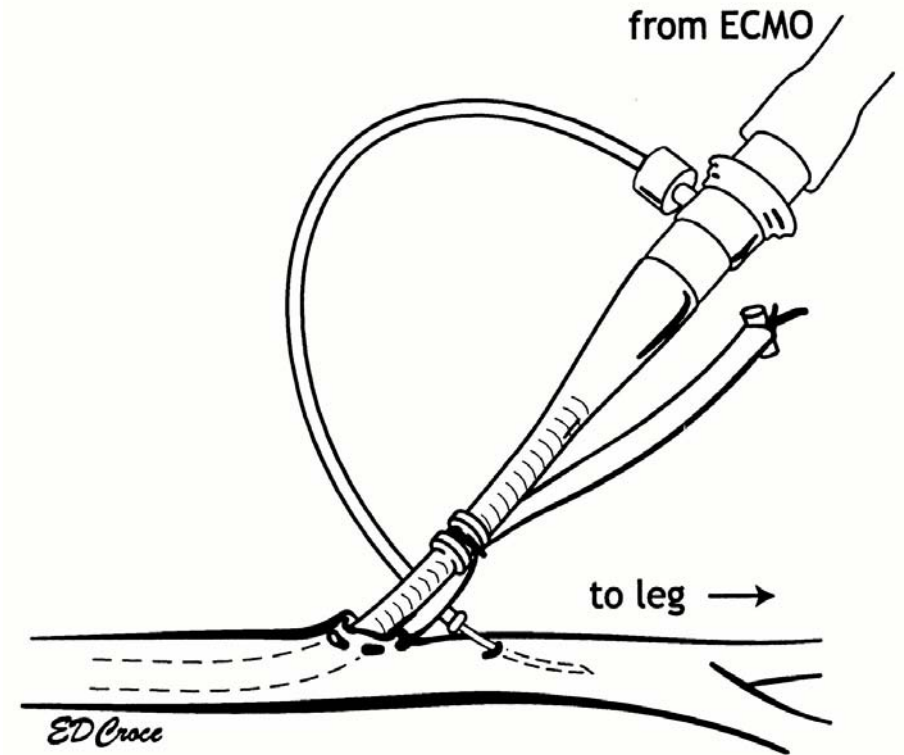
ECMO: Cannulas



femoral
artery
cannulation
site



from ECMO





The ECMO circuit: *Central Unit Controller*





ECMO technique de recours en cas
d'insuffisance cardiaque et/ou
respiratoire réfractaire...

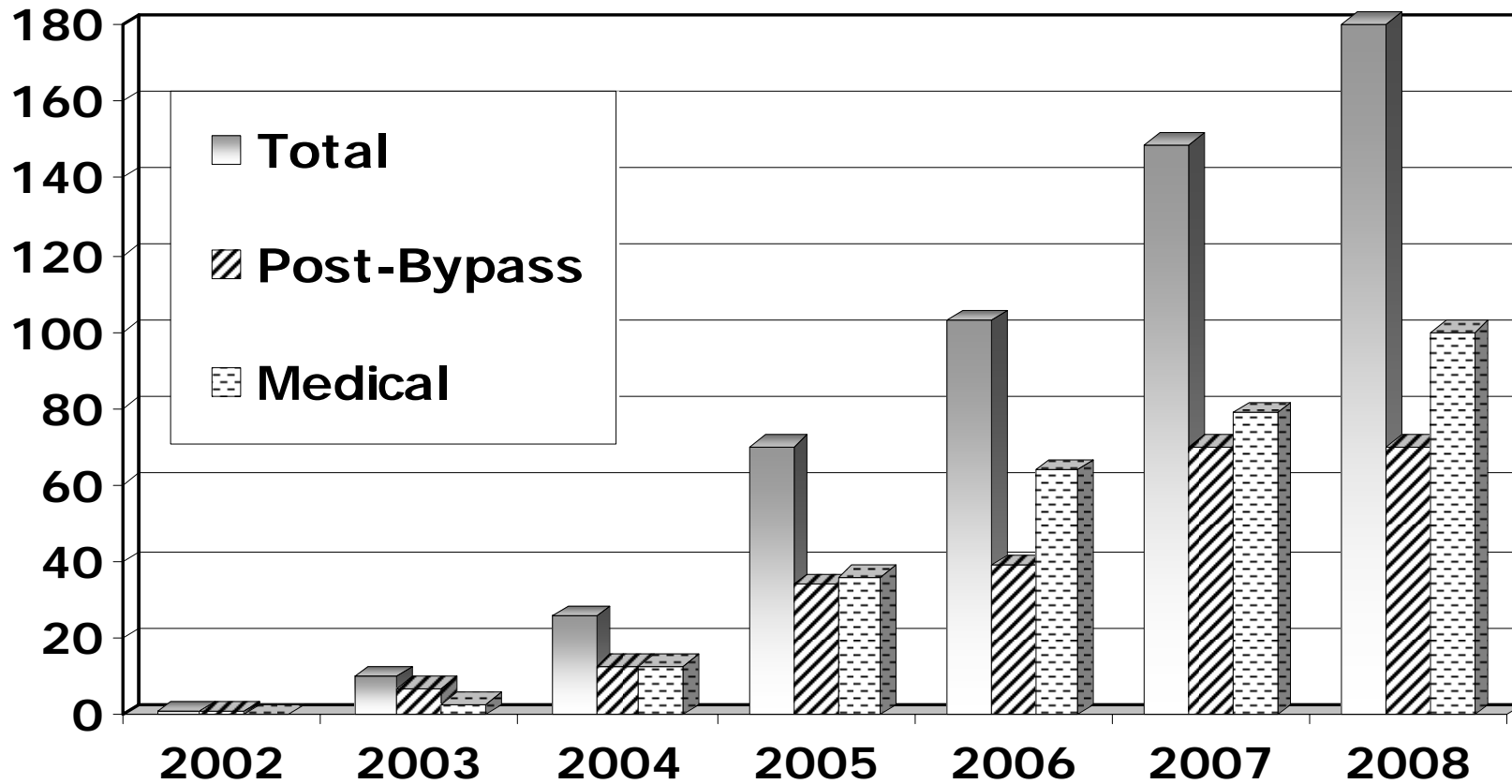


Advantages of ECMO in the setting of cardiogenic shock

- Easy/rapid implantation if peripheral ECMO
 - No sterno/cardiectomy, local anesthesia
 - Emergency situations
- Provides high flow:
 - Up to 7 L/min
- Bridge to: Recovery, Bridge, Transplantation
 - Or whatever seems reasonable...
 - Triage if of doubt about neurological status
 - Mobile Cardiac Assistance Unit
 - For highly unstable patients
- “Low cost”, 2-40 times cheaper/other devices



ECMO program at La Pitié, Paris





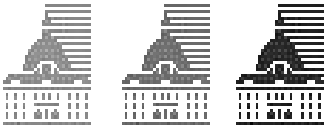
ECMO limitations

- Time limitation: 7 – 21 days
- Patient must remain supine
 - If femoral ECMO
- Local Complications :
 - Hemorrhages, embolism, acute leg ischemia, infection
- Stroke: ischemic, hemorrhagic
- Brain hypoxia if the heart recovers and the lungs are damaged
- Pump highly pre- and afterload dependent
- Non-pulsatile flow?
- Pulmonary edema



Complications

Complications	Central ECMO N= 21	Femoral ECMO N= 60
Femoral bleeding,	-	19 (32)
Mediastinal bleeding	5 (24)	3 (5)
Femoral veins thrombosis	1 (5)	7 (12)
Leg ischemia	3 (14)	12 (20)
Vena cava thrombosis	1 (5)	5 (8)
Femoral site infection	-	10 (17)
Mediastinitis	4 (19)	-
Pulmonary edema	1 (5)	4 (7)
Stroke	3 (14)	4 (7)



Focus sur...

Les complications infectieuses



Nosocomial Infections in Adult Patients Undergoing Extracorporeal Membrane Oxygenation

Jeffrey S. Burket, Robert H. Bartlett,
Kristi Vander Hyde, and Carol E. Chenoweth

Clinical Infectious Diseases 1999;28:828–33

From the Department of Internal Medicine, Division of Infectious Diseases, the Department of Surgery, and the Department of Infection Control and Epidemiology, University of Michigan Health System, Ann Arbor, Michigan

Factor	Infected patients (n = 32)	Uninfected patients (n = 39)	P value
Mean age (y) ± SD	36.0 ± 13.0	33.3 ± 11.9	.37
Sex			
Male	14 (43.8)	15 (38.5)	.83
Female	18 (56.2)	24 (61.5)	
Mean APACHE II score ± SD	16.7 ± 5.58*	17.6 ± 4.57†	.47
Reason for ECMO			
Pneumonia with or without ARDS	17 (53.1)	20 (51.3)	.93
ARDS	7 (21.9)	10 (25.6)	.93
Other pulmonary	5 (15.6)	5 (12.8)	.75
Cardiac dysfunction	3 (9.4)	4 (10.3)	1.00
Mean duration (d) of ventilation ± SD before ECMO	0.91 ± 1.91	0.95 ± 2.10	.93

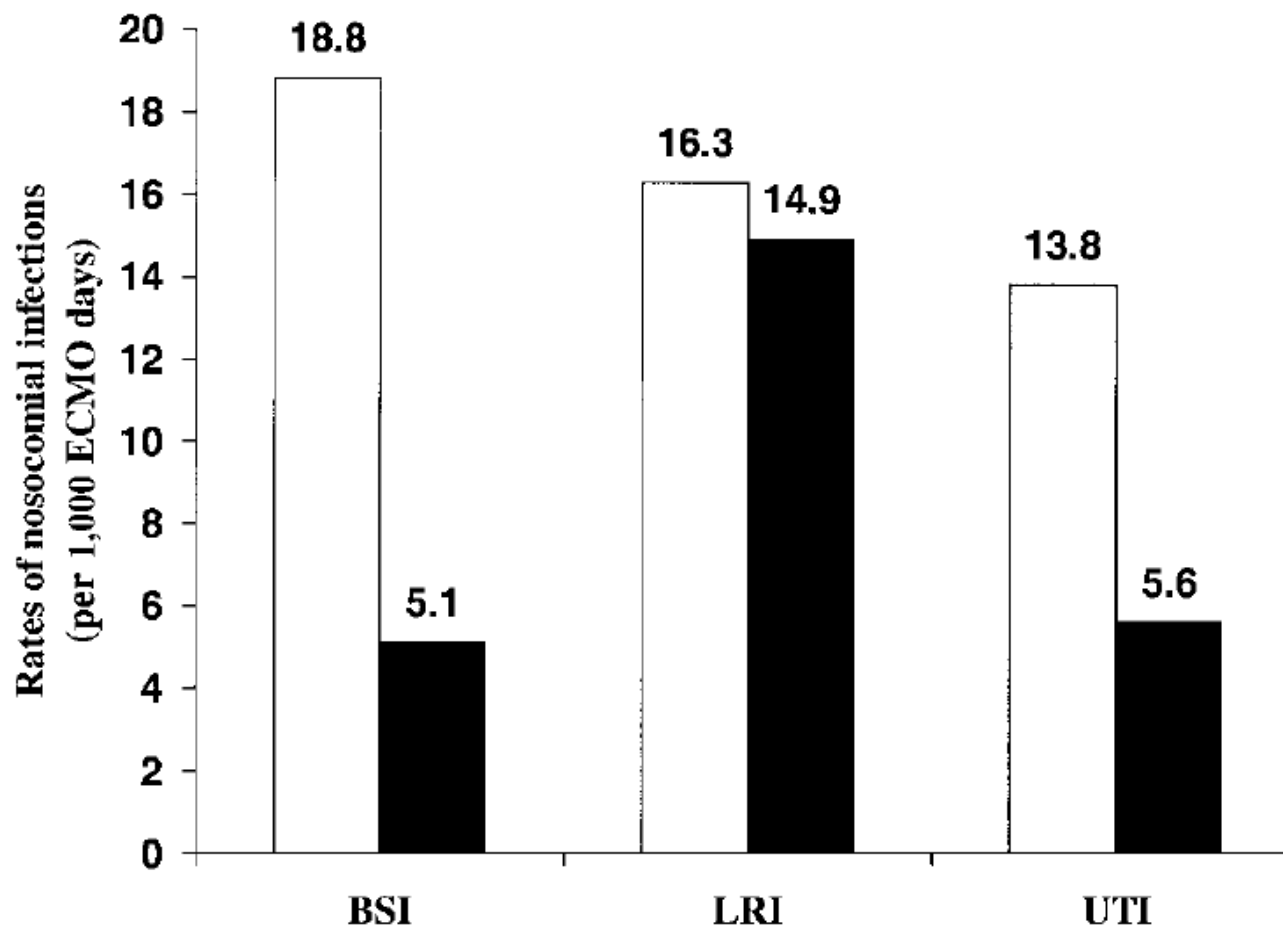


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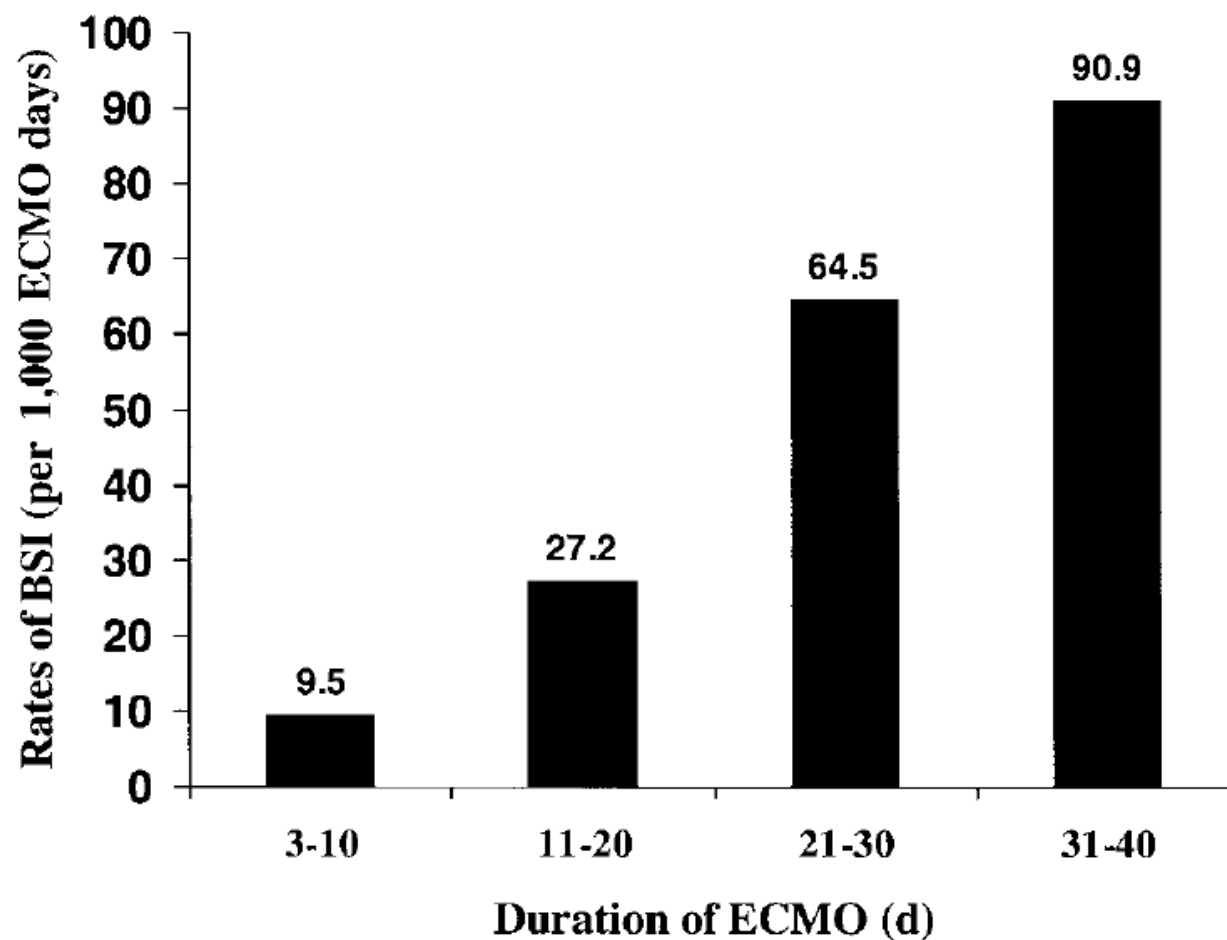


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Table 3. Clinical outcomes for ECMO patients with and without nosocomial infection.

Factor or outcome	Infected patients (<i>n</i> = 32)	Uninfected patients (<i>n</i> = 39)	<i>P</i> value
No. (%) with ECMO survival	18 (56.3)	30 (76.9)	.11
No. (%) with overall survival	13 (40.6)	23 (59.0)	.19
Mean ECMO days* ± SD	14.0 ± 11.0	9.0 ± 6.9	.02
Mean ventilator days ± SD	25.9 ± 19.3	23.7 ± 23.2	.67
Mean ICU days ± SD	27.5 ± 19.6	28.4 ± 28.6	.88
Mean hospital days ± SD	32.1 ± 21.3	33.6 ± 35.3	.83



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Table 2. Microorganisms associated with nosocomial infections in ECMO patients.

BSI (<i>n</i> = 15)*		LRI (<i>n</i> = 13) [†]		UTI (<i>n</i> = 11)	
Organism	No. (%) of infections	Organism	No. (%) of infections	Organism	No. (%) of infections
Coagulase-negative staphylococci	4 (26.7)	<i>Pseudomonas aeruginosa</i>	6 (46.2)	<i>Candida</i> species	8 (72.7)
<i>Enterobacter cloacae</i>	2 (13.3)	<i>Klebsiella pneumoniae</i>	2 (15.4)	<i>Pseudomonas putida</i>	1 (9.1)
<i>Acinetobacter</i> species	2 (13.3)	<i>Haemophilus influenzae</i>	2 (15.4)	<i>P. aeruginosa</i>	1 (9.1)
<i>Enterococcus</i> species	2 (13.3)	<i>Proteus mirabilis</i>	1 (7.7)	<i>E. cloacae</i>	1 (9.1)
<i>Staphylococcus aureus</i>	1 (6.7)	<i>Enterobacter aerogenes</i>	1 (7.7)		
Viridans streptococci	1 (6.7)	<i>Acinetobacter baumannii</i>	1 (7.7)		
<i>Prevotella melaninogenica</i>	1 (6.7)	<i>Serratia marcescens</i>	1 (7.7)		
<i>Lactobacillus</i> species	1 (6.7)	<i>Klebsiella oxytoca</i>	1 (7.7)		
<i>Escherichia coli</i>	1 (6.7)	<i>E. coli</i>	1 (7.7)		
<i>Candida albicans</i>	1 (6.7)	<i>S. aureus</i>	1 (7.7)		
<i>Candida glabrata</i>	1 (6.7)				



Risk factors for nosocomial infection during extracorporeal membrane oxygenation

M.-S. Hsu^a, K.-M. Chiu^b, Y.-T. Huang^a, K.-L. Kao^c, S.-H. Chu^b,
C.-H. Liao^{a,*}

Journal of Hospital Infection (2009) 73, 210–216

Table I Characteristics of patients receiving ECMO with and without development of nosocomial infections

Factors	Non-infected (N = 104)	Infected (N = 10)	P-value
Age	52.19 ± 17.30	42.10 ± 13.90	0.077
Sex (M/F)	72/32	5/5	0.289
Hospital stay before ECMO (days) ^a	6.75 ± 11.79 (0–65)	7.1 ± 6.1 (1–22)	0.927
Underlying condition			
Diabetes mellitus	25 (24.0%)	1 (10%)	0.321
CHF	28 (26.9%)	3 (30%)	0.835
COPD	25 (24.0%)	1 (10%)	0.321
ESRD	2 (1.9%)	0 (0%)	0.658
Liver cirrhosis	0 (0%)	0 (0%)	1.000
APACHE II score ^a	25.5 ± 11.27 (4–56)	20.5 ± 7.42 (14–31)	0.345
TISS score ^a	75.19 ± 17.65 (4–19)	63.83 ± 28.14 (26–91)	0.446
Reason for ECMO			
Cardiogenic/non-cardiogenic	84/20	8/2	0.95
Place of ECMO insertion			
ER/non-ER	14/90	0/10	0.215
ECMO mode			0.716
Veno-arterial	90 (86.5%)	8 (80%)	
Veno-venous	13 (12.5%)	2 (20%)	
Other	1 (1%)	0 (0%)	



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Table 1 Characteristics of patients receiving ECMO with and without development of nosocomial infections

Factors	Non-infected (N = 104)	Infected (N = 10)	P-value
WBC count on ECMO day 1 (/μL)	12 911.94 ± 6905.45	15 958.00 ± 8646.24	0.196
Antibiotics on ECMO day 1	76 (73.1%)	9 (90%)	0.241
Antipseudomonal antibiotics	37 (36%)	3 (33%)	0.724
Glycopeptides	23 (22%)	5 (50%)	0.05
Duration of ECMO (days) ^a	7.41 ± 5.79 (3–46)	23.6 ± 24.46 (6–87)	<0.001
Duration of ICU stay (days) ^a	17.30 ± 15.29 (3–68)	32.00 ± 30.38 (8–105)	0.01
Duration of hospital stay (days) ^a	28.65 ± 33.72	41.90 ± 43.28	0.25
Outcome			
ECMO survival	32 (30.8%)	1 (10%)	0.277
Overall survival	27 (26.0%)	1 (10%)	0.447



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Table II Characteristics of patients who developed nosocomial infections during ECMO use

Case no.	Age/sex	Infection type	Days on ECMO	BT (°C)	WBC ($\times 10^9/L$)	Antibiotics at ECMO initiation	Pathogens	ECMO survival	Survival to discharge
1	57/F	BSI	16	37.8	11.7	LVX + TMP – SMX	<i>E. coli</i>	Yes	Yes
2	46/M	SSI	6	NA	19.1	CZ	No pathogen isolated ^a	No	No
3	21/F	RTI	3	38	8.0	SAM	No pathogen isolated ^b	No	No
4	46/M	RTI	13	37.8	8.7	VA	<i>Pseudomonas aeruginosa</i> , <i>Escherichia coli</i> , <i>Burkholderia cepacia</i>	No	No
5	47/M	RTI	46	37.8	10.7	ATM + VA + CIP	MRSA, <i>Enterobacter cloacae</i>	No	No
		SSI	68	NA	20.0				
6	51/F	BSI	8	NA	15.0	Nil ^c	<i>E. cloacae</i>	No	No
7	51/F	SSI	10	NA	20.9	VA	<i>Candida</i> spp.	No	No
8	55/M	RTI	18	37.6	10.0	MET	<i>E. cloacae</i> , <i>S. maltophilia</i>	No	No
		UTI	37	NA	27.6				
9	23/M	BSI	5	37.5	14.8	VA	<i>P. aeruginosa</i> , <i>E. coli</i> (ESBL)	No	No
10	24/F	SSI	16	NA	12.1	VA + IPM + DIF	<i>E. coli</i> (ESBL), <i>Acinetobacter baumannii</i> , VRE	No	No



Risk factors for nosocomial infection during extracorporeal membrane oxygenation

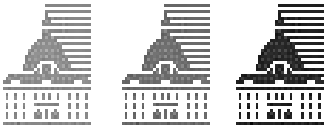
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Table III Univariate and multivariate analysis of risk factors of nosocomial infections during ECMO use

Factors	Univariate analysis			Multivariate analysis		
	OR	95% CI	<i>P</i> -value	OR	95% CI	<i>P</i> -value
Age	0.97	0.92–1.01				
Glycopeptides	0.28	0.08–1.07	0.066	0.232	0.05–1.10	0.066
Duration of ECMO (days)	1.12	1.04–1.22	0.004	1.146	1.04–1.07	0.007
Duration of ICU stay (days)	1.03	1.01–1.06	0.023	0.992	0.94–1.05	0.776

ECMO, extracorporeal membrane oxygenation; OR, odds ratio; CI, confidence interval; ICU, intensive care unit.



L'expérience de la Pitié...

*Infections nosocomiales chez
220 malades assistés par
ECMO VA pour choc cardiogénique*



Outcomes of 220 patients on ECMO

Variable	Uninfected patients (n = 78)	Infected patients (n=142)	P value
Mean age, mean years \pm SD	47.9 \pm 15.1	49.5 \pm 16.9	0.46
Male sex	57 (73.1)	90 (63.4)	0.14
Mean SAPS II score \pm SD	60.4 \pm 19.1	61.3 \pm 20.4	0.76
Mean SOFA score \pm SD	11.6 \pm 4.5	12.6 \pm 4.5	0.17
OMS score \geq 2	23 (29.5)	46 (32.5)	0.65
Mean IMC score \pm SD	25.2 \pm 5.6	25.3 \pm 4.8	0.85
<u>MacCabe score \geq 2</u>	37 (47.4)	57 (40.1)	0.29
Reason for ECMO			0.25
Cardiac arrest	11 (14.1)	17 (12.0)	
Acute myocardial infarction	11 (14.1)	31 (21.8)	
<u>Myocarditis</u>	14 (17.9)	16 (11.3)	
<u>Postcardiotomy</u>	23 (29.5)	55 (38.7)	
CABG	6 (7.7)	12 (8.4)	
Valve procedure	7 (9.7)	7 (4.9)	
CABG and valve procedure	0 (0)	2 (1.4)	
Heart transplantation	6 (7.7)	25 (17.6)	
Others	4 (5.5)	9 (6.3)	
<u>Dilated cardiomyopathy</u>	16 (20.5)	18 (12.7)	
Others	3 (3.8)	5 (3.5)	



Outcomes of 220 patients on ECMO

Variable	Uninfected patients (n = 78)	Infected patients (n=142)	<i>P</i> value
Duration mechanical ventilation, days \pm SD	14.1 \pm 17.8	25.8 \pm 22.0	< 0.001
Mean ECMO days \pm SD	7.8 \pm 5.0	17.3 \pm 19.5	< 0.001
Mean ICU days \pm SD	19.4 \pm 21.4	31.6 \pm 25.2	0.0004
Mean hospital days \pm SD	25.7 \pm 28.8	35.6 \pm 25.9	0.0097
Mean hospital days \pm SD before ECMO	7.7 \pm 14.5	6.2 \pm 11.8	0.41
Mean ICU days \pm SD before ECMO	1.4 \pm 3.7	2.2 \pm 7.5	0.35
Tracheotomy	13 (16.7)	47 (33.1)	0.0088
Intra-aortic balloon pump	15 (19.2)	41 (28.9)	0.11
Mean Intra-aortic balloon pump days \pm SD	4.1 \pm 1.5	6.5 \pm 7.9	0.27
Location of ECMO			
Extra thoracic only	45 (57.7)	54 (38.0)	0.005
Extra thoracic then intra thoracic	9 (11.5)	35 (24.6)	0.02
Extra thoracic then others	2 (2.6)	12 (8.5)	0.07
Intra thoracic only	21 (26.9)	35 (24.6)	0.71
Intra thoracic then others	1 (1.3)	6 (4.2)	0.23



Outcomes of 220 patients on ECMO

Lower respiratory infection (n=163)		Bloodstream infection (n=47)	
Organism	No (%) of infections	Organism	No (%) of infections
<i>Pseudomonas aeruginosa</i>	43 (26.4)	<i>Pseudomonas aeruginosa</i>	10 (21.3)
Polymicrobial	19 (11.7)	<i>Enterococcus species</i>	7 (14.9)
<i>Staphylococcus aureus</i>	16 (9.8)	<i>Escherichia coli</i>	6 (12.8)
<i>Enterobacter species</i>	16 (9.8)	<i>Staphylococcus epidermidis</i>	5 (10.6)
<i>Escherichia coli</i>	14 (8.6)	<i>Staphylococcus aureus</i>	4 (8.5)
<i>Haemophilus influenzae</i>	14 (8.6)	<i>Streptococcus species</i>	3 (6.4)
<i>Klebsiella species</i>	10 (6.1)	<i>Enterobacter species</i>	3 (6.4)
<i>Neisseria species</i>	5 (3.1)	<i>Candida species</i>	3 (6.4)
<i>Proteus mirabilis</i>	5 (3.1)	Anaerobes	2 (4.2)
<i>Streptococcus species</i>	4 (2.4)	<i>Citrobacter species</i>	1 (2.1)
<i>Hafnia alvei</i>	3 (1.8)	<i>Proteus mirabilis</i>	1 (2.1)
<i>Enterococcus species</i>	3 (1.8)	Polymicrobial	1 (2.1)
<i>Serratia marcescens</i>	3 (1.8)	<i>Clostridium species</i>	1 (2.1)
<i>Citrobacter species</i>	2 (1.2)		
<i>Candida species</i>	2 (1.2)		
<i>Staphylococcus epidermidis</i>	1 (0.6)		
<i>Aspergillus</i>	1 (0.6)		
<i>Acinetobacter baumannii</i>	1 (0.6)		
Anaerobes	1 (0.6)		

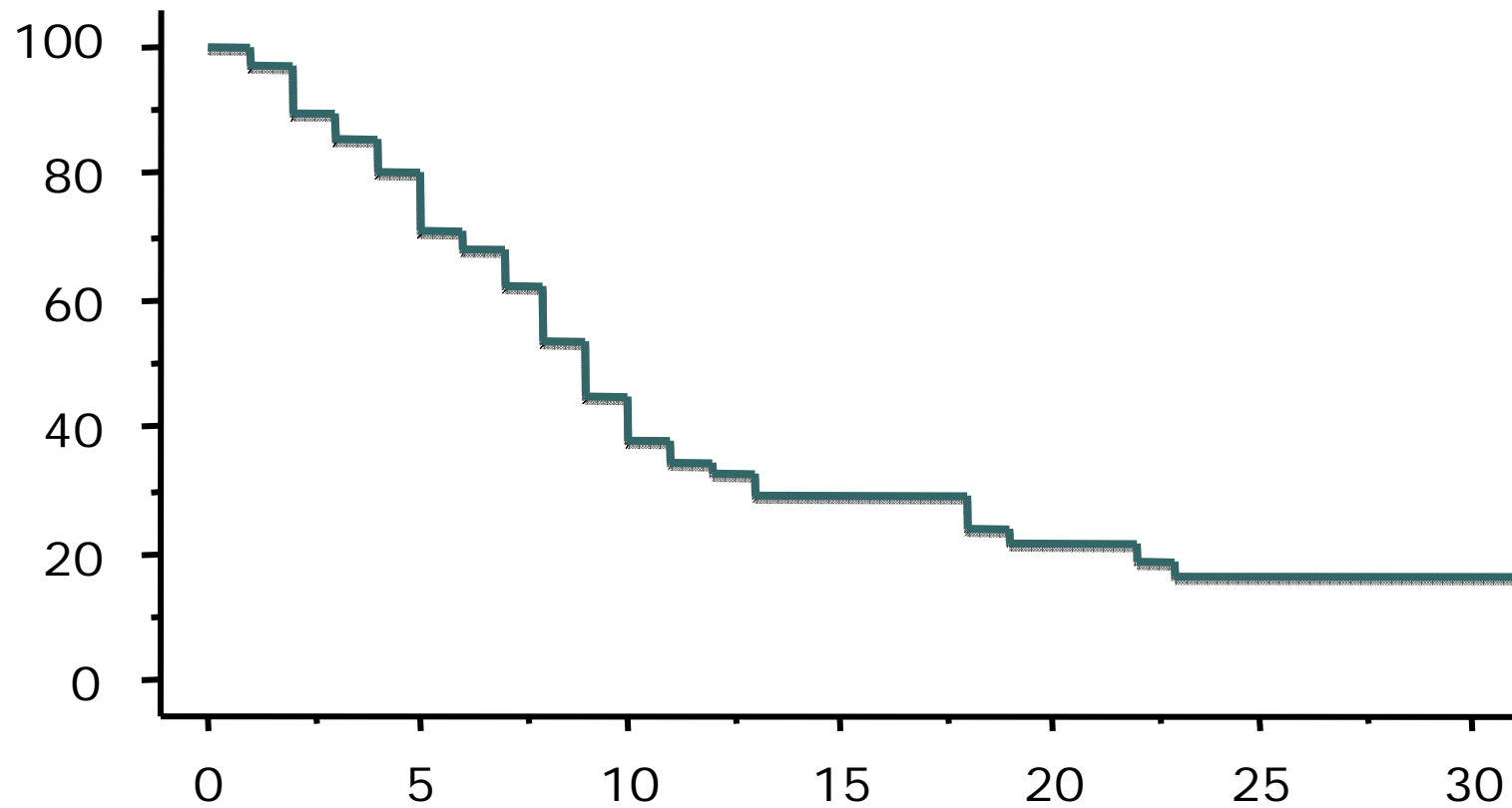


Outcomes of 220 patients on ECMO

<u>Cannula (n=21)</u>		<u>Poststernotomy mediastinitis (n=23)</u>	
<u>Organism</u>	<u>No (%) of infections</u>	<u>Organism</u>	<u>No (%) of infections</u>
<i>Escherichia coli</i>	5 (23.8)	<i>Candida species</i>	8 (34.8)
<i>Enterococcus species</i>	4 (19.0)	<i>Staphylococcus epidermidis</i>	7 (30.4)
<i>Staphylococcus epidermidis</i>	4 (19.0)	<i>Pseudomonas aeruginosa</i>	2 (8.7)
<i>Polymicrobial</i>	3 (14.3)	<i>Staphylococcus aureus</i>	2 (8.7)
<i>Staphylococcus aureus</i>	2 (9.5)	<i>Escherichia coli</i>	2 (8.7)
<i>Pseudomonas aeruginosa</i>	2 (9.5)	<i>Enterobacter species</i>	1 (4.3)
<i>Proteus mirabilis</i>	1 (4.8)	<i>Neisseria species</i>	1 (4.3)



Probability of being infection-free





Facteurs associés infection

	Valeur de p	Exp(Coef)	95% inf.	95% sup.
Durée ECMO	,0090	2,289	1,229	4,262
SOFA >12	<,0001	1,140	1,074	1,209
Antibiotiques avant ECMO	,0233	,386	,170	,879



Facteurs associés décès

	Valeur de p	Exp(Coef)	95% inf.	95% sup.
SAPS II	,0006	1,028	1,012	1,044
Infection canules	,0571	2,781	,969	7,981
Choc septique	,0163	2,302	1,166	4,546
Myocardite	,0009	,126	,037	,430
Homme (vs. Femme)	,0129	,429	,220	,836



Conclusion

- L'ECMO est une technique de recours en cas
 - D'insuffisance cardiaque et/ou respiratoire réfractaire
- ECMO associée à incidence accrue infections nosocomiales
 - PAVM surtout
 - Infections site opératoire peu fréquentes
- Incidence croit avec
 - Durée assistance
 - Sévérité à l'admission
- Ces infections ont un impact pronostique...