Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

machine contamination, and thorough cleaning of the machine and probes after imaging.

Conflict of Interest

None.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1053/j.jvca.2020.04.047.

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COVID-19 Outbreak in France: Setup and Activities of a Mobile Extracorporeal Membrane Oxygenation Team During the First 3 Weeks

To the Editor:

The severe acute respiratory syndrome coronavirus-2–related disease, coronavirus-2019 (COVID-19), mainly is characterized by respiratory manifestations, with approximately 15% to 30% of patients developing acute respiratory distress syndrome (ARDS).[1] The World Health Organization guidelines recommend to proceed to venovenous extracorporeal membrane oxygenation (ECMO) for eligible patients with COVID-19–related ARDS only in centers with "sufficient case volume to ensure clinical expertise."[2] The Amiens ECMO center received many calls from several hospitals in the region about refractory ARDS secondary to COVID-19 during the first weeks after COVID-19 was declared a pandemic. The decision was made rapidly to set up a mobile ECMO team in order to start on-site ECMO treatment.

Start of the Outbreak in Picardy

Located in the north of France, the Picardy region has a population of 1.925 million inhabitants living in a 19,399-km territory. A network of 29 general hospitals is located in this regional territory, with 128 intensive care unit (ICU) beds. The only ICU in Picardy with the ability to manage ECMO is the cardiac thoracic vascular and respiratory unit of Amiens University Medical Centre. The unit has performed about 60 ECMO treatments every year for more than 10 years (one-third of those have been venovenous ECMO treatments).

The COVID-19 outbreak occurred in Picardy at the end of February 2020, resulting in a rapid need for ICU beds. Calls from peripheral centers for ECMO services increased rapidly. In 1 month (March 2020), 676 patients were admitted to the region's hospitals for COVID-19–related disease. Among those patients, 156 required ICU admission (admission rate: 23.1%).[3]

Setting up the Mobile ECMO Team

Clustering infected patients requiring ECMO within an expert center was necessary to ensure adequate care and resource management. A unique phone number was publicized to all ICUs of the region to centralize the request for ECMO services. An on-call ECMO team member was able to give advice and evaluate the need for ECMO. All ECMO team members were educated on the management and eligibility criteria for ECMO initiation. The mobile ECMO team was composed of a specialized intensivist, thoracic surgeon, and trained perfusion nurse. A roster was started in order to make the team available 24 hours a day, 7 days a week. The decision to initiate ECMO treatment was always a multiconsultant decision. The ECMO team was able to reach any hospital in the region in less than 45 minutes (by road or by air, depending on the weather). On arrival to the site, the ECMO team decided whether to perform conventional ventilation or to initiate ECMO on site and transfer the patient on ECMO support. Patients on ECMO were admitted to a specialized ICU with trained staff. The Cardiohelp (Getinge, Gothenburg, Sweden) ECMO device was used for each transport because of its compact and light (10 kg) design.

Number of Calls and Patient Characteristics

During March 2020, 22 calls were received at our ECMO center. The ECMO team initiated 8 venovenous ECMO treatments on site and transferred 3 patients on conventional ventilation. For all patients, the drainage cannula (size 25 F) was inserted in the right femoral vein and the return cannula (size 19 F) was inserted in the right jugular vein. Heparin treatment was started after the procedure with continuous perfusion of unfractionated heparin

Table 1
Patient Characteristics Before ECMO Procedure

Variables	Cases							
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Age (y)	63	41	59	67	55	62	64	46
BMI (kg/m^2)	29	27	49	30	22	38	29	29
Smoking	No	Yes	No	No	No	No	No	No
Hypertension	No	Yes	No	No	No	Yes	No	Yes
Diabetes	No	Yes	No	No	No	Yes	No	No
NSAIDs/corticoids/ID	No	Yes	No	Yes	Yes	No	Yes	No
SOFA	4	16	13	11	8	9	14	11
SAPS II	36	70	51	76	38	64	65	60
Vasopressors (μg/kg/min)	0	0.4	0	0	0	0.2	0	0
Tidal volume (mL/kg)	5.8	4.2	6.4	6.1	4.8	5.6	6.5	4.5
Respiratory frequency	30	32	30	30	30	30	31	35
PEEP (cmH_2O)	10	12	10	10	10	14	12	16
Driving pressure (cmH_2O)	15	9	20	17	20	12	15	14
Compliance (mL/cmH_2O)	23	30	28	26	18	33	30	23
PaO_2/FiO_2	51	67	52	57	69	73	95	87
ARDS Berlin grade	3	3	3	3	3	3	3	3
Number of days of mechanical ventilation	3	4	1	1	9	4	7	3
Number of prone positions before ECMO procedure	2	2	1	1	3	3	3	1
Chest CT scan								
Ground-glass opacities	N/A	N/A	Diffuse	Diffuse	Diffuse	Diffuse	Diffuse	Diffuse
Consolidations	N/A	N/A	Diffuse	Diffuse	Posterior	Diffuse	Posterior	Posterior
Crazy paving	N/A	N/A	No	No	Yes	Yes	No	No
Degree of extension	N/A	N/A	>75%	>75%	>50%	>50%	>50%	>50%
Lymphocyte count (per mm^3)	400	400	900	400	700	500	12,300*	200
Fibrinogen (g/L)	6.9	3.7	6.9	6	5.7	>9	4.9	5
CRP (mg/L)	177	194	325	295	360	480	219	301
Outcome at 28 d								
Discharged from ICU	No	Yes	No	Yes	Yes	No	No	Yes
In ICU weaned from ECMO	No	No	Yes	No	No	No	No	No
Remained on ECMO	No	No	No	No	No	No	Yes	No
Died in ICU	Yes	No	No	No	No	Yes	No	No
ECMO support duration (d)	26	10	17	8	22	26	28	14
Complications during ECMO								
Thrombosis	No	No	No	No	No	No	No	No
Bleeding	No	No	No	No	No	Yes	No	Yes
Cannula infection	No	No	Yes	No	No	No	No	No
Need for membrane change	No	No	No	No	Yes	Yes	Yes	No

Abbreviations: ARDS, acute respiratory distress syndrome; BMI, body mass index; CRP, xxx, CT, computed tomography; ECMO, extracorporeal membrane oxygenation; FiO_2, fraction of inspired oxygen; ICU, intensive care unit; ID, immunodepression NSAIDs, nonsteroidal anti-inflammatory drugs; PaO_2, partial pressure of oxygen; PEEP, positive end-expiratory pressure; SAPS II, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment.
* Patient with chronic lymphoid leukemia.

for an anti-XA level target of 0.2 to 0.4 UI/mL. Despite this treatment, cannula thrombosis occurred in 2 patients, leading to procedure failure and death for both patients. This probably was due to the high inflammatory state that increases the risk of thrombosis, as suggested in some reports.[4] The ECMO team was not available 3 times due to simultaneous calls. Only 1 ECMO treatment was initiated during a night shift. Four patients (50%) were discharged from the ICU. Characteristics, outcomes, and complications of the patients are detailed in Table 1. The role of ECMO in COVID-19−related ARDS still is unclear. To date, only limited case series are available. Our report is in accordance with previous reports on limited cases series of COVID-19 patients on ECMO support. Li et al. reported a similar rate of 50% of weaning for 8 patients on ECMO.[5] Jacobs et al., in a larger case series of 32 COVID-19 patients on ECMO, had a weaning rate of 16% (5 of 32), but the majority of their ECMO treatments still were ongoing at the time of publication.[6] In contrast to other case series, we performed only venovenous ECMO therapies because all treated patients were hemodynamically stable without acute ventricular dysfunction.[7]

To conclude, the setup of a mobile ECMO team within an experienced ECMO center is feasible and may help in the treatment of COVID-19 patients. To date, there are only limited case series regarding ECMO for COVID-19 patients, and larger studies are mandatory to draw any conclusion. However, sharing the experience among ECMO expert centers is necessary to improve our practice.

Conflict of Interest

None.

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Thromboelastometry and D-Dimer Elevation in Coronavirus-2019

To the Editor:

SEVERE elevation of D-dimer is a hallmark of septic shock and a predictor of mortality in coronavirus-2019 (COVID-19) disease.[1] D-dimer reflects the extent of plasmin-mediated degradation of cross-linked fibrin, thereby causing intravascular coagulation. Use of thromboelastometry has gained popularity to assess systemic fibrinolysis in liver transplantation and major trauma,[2] but its utility has not been fully elaborated in the critical care setting.[3] We therefore analyzed the laboratory and thromboelastometry data from 11 critically ill patients receiving mechanical lung ventilation and intensive care support for COVID-19 at the R Adams Cowley Shock Trauma Center over a 2-day period. The Institutional Review Board approved the study. Patients were characterized as follows (data in median [25%-75% quartiles] or percentage); median age 53 years (45.5-65.5 y), body mass index 28.1 (27.1-34.6), 64% male, 54.5% hypertensive, and 45.5% diabetic. Patients were dichotomized into 2 groups on the basis of D-dimer levels 5 times the upper limit of normal (649 ng/mL fibrinogen equivalent unit). Three of 6 patients in the high D-dimer group were on extracorporeal membrane oxygenation support. Despite highly significant C-reactive protein and D-dimer elevations in the latter group, systemic fibrinolysis was not detected either on EXTEM or FIBTEM (maximal lysis 0%). D-dimer has a half-life of about 8 hours and reflects in vivo thrombus formation.[4] On the other hand, thromboelastometry only measures the reserve hemostasis capacity in the collected blood using a high-dose coagulation trigger (eg, tissue factor). Tissue plasminogen activator is an important trigger of fibrinolysis in vivo, but its half-life is normally less than 3 minutes.[5] Circulating plasminogen activator inhibitor-1 levels are increased during Severe Acute Respiratory Syndrome (SARS) corona virus infection.[6] Systemic fibrinolysis thus is unlikely to occur in COVID-19 patients with cytokine storm (Table 1).

Raza et al. previously showed that only 5% of trauma patients had fibrinolysis on ROTEM, whereas 57% of patients had moderate fibrinolysis with a median D-dimer level of 38,687 ng/mL.[7] In our patients, a median D-dimer fibrinogen equivalent unit of 15,465 ng/mL and fibrinogen 734 mg/dL showed that only 0.21 % of fibrinogen was converted to D-dimer. In contrast, the data in the study by Raza et al showed that 1.84% of fibrinogen (median 210 mg/dL) was converted to D-dimer. Taken together, critically ill COVID-19 patients demonstrated significant elevations in D-dimer consistent with microvascular thromboses, but only small fractions of fibrin seem to be broken down locally and systemic fibrinolysis is rarely observed.

Table 1
Laboratory Data of Patients with Moderate versus Severe D-Dimer Elevations

	D-Dimer (ng/mL)	
	≤3,245	>3,245
Standard laboratory	n = 5	n = 6
CRP (mg/dL)	4.9 (3.8-26.1)	27.5 (13.0-32.7)
D-dimer (ng/mL)	2,410 (1,220-2,800)	15,465 (8,050-19,730)
Fibrinogen (mg/dL)	478 (351-1,057)	734 (567-1,016)
Hematocrit (%)	28.4 (24.4-30.3)	25.9 (22.1-28.7)
Platelet ($\times 10^9$/mL)	211 (152-269)	144 (104-301)
PT (sec)	14.7 (13-14.7)	15.1 (14.9-15.4)
Thromboelastometry		
EXTEM-CT (s)	73 (69-74)	76.5 (73-91.5)
EXTEM-A10 (mm)	63 (60-70)	67 (61.5-68.9)
FIBTEM-A10 (mm)	30 (30-36)	36.5 (32.8-43.4)
EXTEM-ML (%)	0	0

NOTE. Thromboelastometry was performed on the ROTEM Delta (TEM Innovations, Munich, Germany). EXTEM and FIBTEM reagents contain hexadimethrine bromide, that neutralizes heparin. Five patients in the high D-dimer group were on intravenous heparin. Reference ranges: C-reactive protein <1 mg/dL; D-dimer <640 ng/mL fibrinogen equivalent unit; fibrinogen 216-438 mg/dL; hematocrit 37%-50%; platelet 153-367 $\times 10^9$/mL; prothrombin time 9.6-11.2 sec; EXTEM clotting time 43-82 seconds; EXTEM clot amplitude at 10 minutes 46-67 mm; FIBTEM clot amplitude at 10 minutes 7-24 mm; EXTEM maximal lysis <15%.
Abbreviations: A10, clot amplitude at 10 minutes; CRP, C-reactive protein; CT, clotting time; ML, maximal lysis; PT, prothrombin time.