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.

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Letter to the Editor

"MoRPHEE" fighting COVID-19

To the Editor,

Since its emergence in China in late 2019, the Coronavirus (COVID-19) outbreak has rapidly posed a serious threat to the health systems worldwide [1]. COVID-19 spread globally including in France, as in much of mainland Europe, in early March 2020. On March 11, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak to be a pandemic [2].

There are particular challenges in the management of severe acute respiratory distress syndrome due to COVID-19 (SARS-CoV-2), such as a rapid surge in the number of critically ill patients who require intensive care. This creates a high risk of intensive care unit (ICU) saturation.

On March 17, 2020, the first in a series of official confinement measures were announced. On that day in France, 7730 positive COVID-19 patients were confirmed of whom 699 were admitted to the ICU [2]. The distribution of COVID-19 cases within mainland France was heterogeneous. Most cases were located in the Grand Est region where ICUs' capabilities were saturated [2].

The French Government made the decision to transfer ICU patients with SARS-CoV-2 from Grand Est to other regions with ICU availability, in order to increase the chances for the maximum number of patients to receive the required cares.

The French Air Force and the French Military Health Service (FMHS) were engaged and deployed their collective airborne medical evacuation (MEDEVAC) plane, an Airbus A330 equipped with the MoRPHEE (*Module de Réanimation pour Patient à Haute Elongation d'Evacuation*) system [3]. MoRPHEE transforms the plane into a "flying-ICU" for the long-distance transport of critically ill patients (Fig. 1). MoRPHEE is usually dedicated to the collective MEDEVAC of French soldiers injured during combat. Since 2006, 5 MoRPHEE missions had been performed, allowing the repatriation of more than 50 soldiers. The MEDEVAC team is composed of 3 intensive care practitioners, 3 nurse anaesthetists , 2 flight-surgeons, 2 nurses, and 2 flight-nurses all specifically trained on MoRPHEE [4]. Due to the biological risk and its management onboard, the MEDEVAC team was reinforced by 2 practioners specialised in the management of B risk and issued of the Biomedical Research Institute of the Faculty of Medical and Health Sciences (FMHS).

Fighting COVID-19, 6 MEDEVAC missions were performed on March 18, 21, 24, 27, 31 and April 3, which allowed the medical transport of 36 ICU patients with SARS-CoV-2 (6 missions of 6 patients).

Patients were issued of the Mulhouse area's ICUs and embarked at the EuroAirport Basel Mulhouse, or from the Metz area (embarked at Luxembourg airport). The destinations were Istres airport (for Marseille and Toulon ICUs), Brest, Bordeaux (twice), Hamburg (Germany) and Toulouse.

Fig. 1. PHENIX plane medically equipped with the MoRPHEE systems. Photo credits: Mathieu Boutonnet.

Table 1
Onboard respiratory management.

Variables	N = 36
Ventilatory settings, median (IQR)	
Tidal Volume/Predicted Body Weight, ml.kg^{-1}	6,5 (6,2-7,0)
Respiratory Rate, min^{-1}	25 (22-26)
Inspired Oxygen Fraction, %	55 (50-60)
Positive End Expiratory Pressure, cmH_2O	13 (12-14)
Duration of on-board mechanical ventilation, median (IQR), min	185 (145-198,5)
Patient centered issues	
PaOz/FiO2 ratio, median (IQR), mmHg (n = 30)	143 (119-185)
Hypoxemia episodes (SpO2 < 90% over at least 5 min), No.	2
Oxygen intake	
Hourly, median (IQR), L.patient-^{1}.h-^{1}	564 (482-675)
Per flight, median (IQR), L.patient^{-1}	1650 (1350-1950)

The mission typically starts on day-1, with the expression of a transfer requirement by the Grand Est Health Regional Agency. A phone conference was held in order to coordinate the selection of patients, the first road transport to the airport, the boarding manoeuvre, the disembarking manoeuvre and the second road transport to the receiving hospital.

The selection criteria were as following: no ongoing prone-position ventilation, PaO2/FiO2 ratio around 150 (possible at 120), norepinephrine infusion ratio < 5 mg.hour^{-1}, weight < 120 kg. The selection of patients was under the ICU and SAMU 68 or SAMU 57 responsibility. The destination of the patients was under the responsibility of the receiving hospital and Health Regional Agencies. Information regarding the patients' transfer was given to their families by the ICU medical teams.

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After the conference, direct phone contact and medical transmissions were established between the MoRPHEE and the ICU medical teams. Boarding and disembarking manoeuvres were established and coordinated by the MoRPHEE medical director who sent the directives to the medical SAMU directors in order to ensure the onboard transfers.

On day-D, at 07:00 a.m., a second phone contact was established in order to verify that no medical aggravation had occurred during the night and that patients were still transportable. On the 6 missions, a total of 6 patients had to be replaced.

The MEDEVAC team was briefed by the medical director and at 08:00 a.m. the team acceded to the plane in order to finalise the preparation of the 'flying-ICU' (drugs, check-lists, medical files...). At 10:00 a.m., MoRPHEE took off from Istres to its destination located in the Grand Est region. At 11:30 a.m. boarding of the patients usually started. Boarding manoeuvres lasted between 53 and 88 minutes depending on the severity of patients and technical concern with boarding platforms. MEDEVAC flight lasted between 52 and 75 minutes and disembarking lasted between 60 and 100 minutes.

The Table 1 summarises the onboard respiratory management of the patients. More than two thirds of the patients received catecholamine infusion. We did not encountered life-threatening event during flight.

In conclusion, we report here the first experience of collective aeromedical evacuation of patients with ARDS. These MEDEVACs were performed in the context of the COVID-19 pandemic and under the pressure of a constant biological risk threatening the MEDEVAC teams. Collective aeromedical evacuation of critically ill patients provided a reliable solution to relieve the burden of the disease at both national and international levels.

Disclosure of interest

The authors declare that they have no competing interest.

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