How do we fight COVID-19? Military medical actions in the war against the COVID-19 pandemic in France

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ABSTRACT

‘We are at war’, French President Emmanuel Macron said in an address to the nation on 16 March 2020. As part of this national effort, the French Military Medical Service (FMMS) is committed to the fight against COVID-19. This original report aimed to describe and detail actions that the FMMS has carried out in the nationwide fight against the COVID-19 pandemic in France, as well as overseas. Experts in the field reported major actions conducted by the FMMS during the COVID-19 pandemic in France. In just few weeks, the FMMS developed ad hoc medical capabilities to support national health authorities. It additionally developed adaptive, collective en route care via aeromedical and naval units and deployed a military intensive care field hospital. A COVID-19 crisis cell coordinated the French Armed Forces health management. The French Military Centre for Epidemiology and Public Health provided all information needed to guide the decision-making process. Medical centres of the French Armed Forces organised the primary care for military patients, with the widespread use of telemedicine. The Paris Fire Brigade and the Marseille Navy Fire Battalion emergency departments ensured prehospital management of patients with COVID-19. The eight French military training hospitals cooperated with civilian regional health agencies. The French military medical supply chain supported all military medical treatment facilities in France as well as overseas, coping with a growing shortage of medical equipment. The French Armed Forces Biomedical Research Institute performed diagnostics, engaged in multiple research projects, updated the review of the scientific literature on COVID-19 daily and provided expert recommendations on biosafety. Finally, even students of the French military medical academy volunteered to participate in the fight against the COVID-19 pandemic. In conclusion, in an unprecedented medical crisis, the FMMS engaged multiple innovative and adaptive actions, which are still ongoing, in the fight against COVID-19. The collaboration between military and civilian healthcare systems reinforced the shared objective to achieve the goal of ‘saving the greatest number’.

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Key messages

► As part of the national effort, the French Military Medical Service was committed to the fight against COVID-19, involving all its departments.
► Within a global medical system, innovative, dedicated interventions brought together adaptive solutions to issues encountered in the COVID-19 pandemic.
► Unprecedented and unique actions were conducted, including the use of a military intensive care field hospital and multiple collective aeromedical evacuations of patients with severe acute respiratory distress syndrome.
► Dedicated military strategies have been adopted for the management of patients in France, as well as in overseas military operations.

Providing care as close to the frontline as possible is the ultimate mission of the French Military Medical Service (FMMS).1,2 Beyond this primary mission, the FMMS makes a significant contribution to the field of public health and the design of government risk-management plans intended to deal with health crises and terrorist threats.3,4 In the spring of 2020, COVID-19 spread through France. ‘We are at war’, French president Emmanuel Macron said in an address to the nation on 16 March 2020. ‘The enemy is invisible, and it requires our general mobilisation’. By mid-April, over 100 000 COVID-19 cases were confirmed in France.9–11 As part of the national effort, the FMMS was committed to the fight against COVID-19, involving all its departments. This report describes (Figure 1) the actions carried out by the FMMS in the fight against the COVID-19 pandemic in France, as well as overseas.

Experts in the field reported the following major actions conducted by the FMMS during the COVID-19 pandemic in France.

COVID-19 CRISIS RESPONSE CELL OF THE FMMS SURGEON GENERAL OFFICE

As early as February 6, 2020, the FMMS Surgeon General Office initiated a COVID-19 crisis cell to coordinate actions related to the COVID-19 pandemic.12 13 The purpose of this response cell was to ensure continuity and ongoing adaptation of military medical support while responding to the public health authorities’ requests for assistance.14–16 This twofold challenge involved maintaining the French Armed Forces operational capabilities at home and in overseas military operations while ensuring the health of military personnel and limiting the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). From 6 April, more than 20 000 virtual consultations were conducted.17 The use of teleworking enabled military and medical teams to preserve human resources and to conduct all core missions of the French Armed Forces, including the new COVID-19 French
population-supporting Operation RESILIENCE. In overseas military operations, the FMMS doctrine is based on early damage control resuscitation and surgery, combined with early strategic aeromedical evacuations. These principles were applied to patients with COVID-19, intending to limit the incidence of severe COVID-19 cases in overseas military operations. A strategy was implemented in overseas military operations for the systematic, early aeromedical evacuation of all patients presenting with respiratory symptoms or low-risk factors. Furthermore, in just a few weeks, the FMMS developed ad hoc medical capabilities to support national health authorities: adaptive en route care aeromedical capabilities and a military intensive care field hospital.

Collective aeromedical evacuations of civilian critically ill patients with COVID-19
The French Air Force and the FMMS deployed a collective aeromedical evacuation (aero-MEDEVAC) system. This system used a military A330 Airbus, equipped with a resuscitation module for high elongation evacuation (MoRPHEE Module de Réanimation pour Patient à Haute Elongation d’Évacuation) system which transformed the plane into an intensive care unit (ICU) for a long-distance aero-MEDEVAC of six critically ill patients (Figure 2). A total of six aero-MEDEVAC systems transferred 36 patients with COVID-19. The six aero-MEDEVAC flights lasted between 52 and 77 min, with distances ranging from 700 to 1080 km. All patients received protective mechanical ventilation. Two patients experienced severe hypoxaemia episodes. No other serious respiratory adverse events occurred, and no life-threatening event was reported.

Conception and deployment of a 30-bed military intensive care field hospital in Eastern France
Following the order of the French president, the FMMS designed a 30-bed military intensive care field hospital. In an unprecedented manner, the Élément Militaire de Réanimation du Service de Santé des Armées (EMRSSA, field ICU of the FMMS) offered a fully integrative intensive care system. The EMRSSA joined and supported the Emile Muller hospital in Mulhouse. Prior to the EMRSSA deployment, the Emile Muller Hospital increased the number of available ICU beds from 36 to 62. The EMRSSA offered 30 additional ICU beds. The EMRSSA field hospital aimed to achieve two main objectives: first, to treat critically ill patients with COVID-19-associated acute respiratory distress syndrome (ARDS) according to the best standards of care and, second, to protect caregivers. Fully equipped with high standard of devices for critical care, three ICU wings were progressively set up. Figure 3 shows a general overview of the EMRSSA, and Figure 4 displays a view of an EMRSSA ICU wing. In the first 3 weeks, more than 40 COVID-19 critically ill patients were transferred into the EMRSSA. All patients presented with ARDS and required protective mechanical ventilation. Each ICU wing was staffed following appropriate structural and organisational requirements for ICUs. The protection of the EMRSSA personnel was one of two main objectives of the
mission. With advising from an infection control team, the EMRSSA was separated into three different zones according to different protection levels: a green zone (wearing of a surgical mask), an orange zone (wearing of an FFP2 mask) and a red zone (wearing of full personal protective equipment: FFP2 or FFP3 mask, gown, gloves, eye protection and apron).29

Naval evacuation of civilian patients with COVID-19
The French Navy amphibious assault ship Tonnerre was deployed on 22 March 2020 to conduct a naval medical evacuation of 12 critically ill patients with COVID-19 from hospitals on the Corsica island to different ICUs in Marseille, mainland France. On-board hospital capacities were upgraded and reorganised into an ICU for extended transport, with biohazard constraints.30 31 Standard medical equipment was upgraded, including mechanical ventilators, patient monitors, and point-of-care blood gases analysers. The naval medical team was reinforced by a civilian-military intensivist team, one bacteriologist, four certified registered nurse anaesthetists, six ICU registered nurses, one imaging assistant, and one laboratory assistant. The total naval transfer delay was less than 20 hours. No complications were reported for any of the 12 patients.

Reorganisation of the Department of Armed Forces Medicine for primary care of military patients and continuity of the Armed Forces medical support
Medical centres of the French Armed Forces organised primary care for military patients, including their families, to prevent the risk of SARS-CoV-2 infection. As a result, two medical
consultation circuits were established in all military medical centres: one for patients suspected of being positive for COVID-19 and a second for patients not suspected of being positive for COVID-19. Since 6 April 2020, more than 30,000 medical consultations occurred, including 9,429 ambulatory follow-ups for patients with COVID-19. During the same period, the military medical centres conducted 22,289 virtual consultations. Telemedicine emerged as an appropriate way to monitor signs of COVID-19 among contacts of stay-at-home patients with COVID-19. Fifty physicians, flight surgeons, nurses and caregivers of the Department of Armed Forces Medicine participated actively in the medical transport of 120 critically ill patients with COVID-19 by military aircrafts or helicopters, battleships, trains or ambulances. Moreover, 10 military critical care teams were trained to reinforce overseas military operations in the context of the COVID-19 pandemic.

PREHOSPITAL MANAGEMENT OF PATIENTS WITH COVID-19 BY BASIC AND ADVANCED LIFE SUPPORT TEAMS OF THE PARIS FIRE BRIGADE AND THE MARSEILLE NAVY FIRE BATTALION EMERGENCY DEPARTMENTS

The Paris Fire Brigade is a military unit of the army whose primary and permanent role is operational defence of the populations in the greater Paris area. Between 1 February and 20 April, the Paris Fire Brigade basic life support teams cared for 9,445 patients with COVID-19 in the prehospital setting, leading to 6,044 hospital admissions and 3,401 discharged at home. In the same period, the Paris Fire Brigade advanced life support teams cared for 333 patients with COVID-19 in the prehospital setting, including 76 severe cases requiring a prehospital tracheal intubation, invasive mechanical ventilation and ICU admission. These advanced life support teams participated in 48 aero-MEDEVAC of ICU patients hospitalised for COVID-19 ARDS. The Paris Fire Brigade operation centre received and processed all the calls transmitted from emergency numbers and contributed directly to the solving of operational situations and to a synergy between different services that participated in the crisis management in the Parisian zone. The Alerts Processing Centre received more than 6,000 calls per day and engaged the rescue teams around 1,400 times. It activated and managed the basic advanced life support and advanced life support teams, especially in treating clinical COVID-19 presentations.

Eight similar to the Paris Fire Brigade, the Marseille Navy Fire Battalion is a military fire department unit of the navy dedicated to the protection of Marseille, the second-largest city in France. From the beginning of the COVID-19 pandemic, the prehospital medical emergency service of the Marseille Navy Fire Battalion adapted its procedures and ambulance equipment to cope with COVID-19 challenges. Between 1 February and April 30, the basic life support teams of the Marseille Navy Fire Battalion managed 1,185 patients with suspected COVID-19, with 125 patients requiring the intervention of an advanced life support team. A total of 1,019 patients were admitted to a hospital and 166 were discharged. Advanced life support teams transferred 12 patients from the airport (aero-MEDEVAC) and the seaport (navy-MEDEVAC) to civilian and military ICUs in Marseille, and helped to transfer 15 patients from one ICU to another in the city. Medical teams also contributed to COVID-19 diagnostic screening in retirement homes to help the National Health Services; more than 900 residents and social workers were involved in this effort. One medical chemical, biological, radiological and nuclear defence expert also contributed to the development of the COVID-19 Marseille Environmental Testing project. The project aimed to detect SARS-CoV-2 in the environment by performing RT-PCR on samples and thus improving decontamination protocols.

EIGHT FRENCH MILITARY TRAINING HOSPITALS IN ORIGINAL INTERACTION WITH CIVILIAN HOSPITAL ORGANISATION

The eight military training hospitals are spread throughout France. The medical director of each one is the FMMS representative to the regional health agencies, monitoring the interactions between public health needs and the military’s capabilities. The collaborations in Eastern France since March 2020 illustrated such interactions: the delivery of 20 mechanical ventilators from the French military medical supply chain to the Eastern France Regional Health Agency; the set-up of aero-MEDEVAC for 90 patients from civilian ICUs in Mulhouse to other ICUs in France, Germany, Luxembourg, Switzerland and Austria; and the admission of 383 patients in Legouest Military Training Hospital (Metz). In the context of the COVID-19 pandemic, and the anticipation of mass casualties in the ICUs, experts from the eight French military training hospitals and the Val-de-Grâce Military Medical Academy proposed a dedicated crisis organisational strategy to the French Society of Anesthesia & Intensive Care Medicine. The objective was to increase the number of ICU beds available to serve the greatest number of patients. New ICU beds were created outside the perimeter of ICUs: intermediate care units, recovery rooms and even inside operating theatres. In each military training hospital, the numbers of ICU beds multiplied between 1.5 and 2.0. In response to the mass casualty concerns, military training hospitals set up ventilation weaning units to remove patients from ICUs while they were still ventilated, as previously reported for trauma patients. Before May 2020, the eight military hospitals admitted 9,268 patients, with 2,419 hospitalisations, and 472 patients in the ICU. The military training hospitals and, specifically, Bégin Military Training Hospital (Saint-Mandé), specialised in the field of infectious disease, conducted dedicated actions:

- Diagnostic and treatment of military patients with COVID-19.
- Molecular diagnostic by RT-PCR for cluster investigations, epidemiological surveys, screening before returning to duty or before deployment in overseas military operations, and provision of serological tests.
- 24/7 national medical call centre for diagnostic and therapeutic advice.
- Edition of dedicated procedures for realisation of nasopharyngeal swab specimen, use of personal protective equipment, infection prevention and control, and review of medical protocols.
- Deployment of molecular diagnostic tools in French military field laboratories in overseas military operations.

GROWING SUPPORT OF THE FRENCH MILITARY MEDICAL SUPPLY CHAIN

The French military medical supply chain is composed of a central office, an institution in charge of purchasing and payments, two pharmaceutical establishments for distribution of health products, an institution specialised in studies, maintenance and distribution of medical equipment, a pharmaceutical drug production facility and a dedicated blood transfusion centre. Its mission is to acquire health products, supply medical units on the national territory, as well as in overseas military operations, and maintain strategic stocks and medical equipment. From 7 March 2020, the French military medical

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supply chain integrated the French Armed Forces COVID-19 crisis cell. Moreover, the French military medical supply chain conducted repeated emergency procurement procedures to face strains on health product supplies. The French military medical supply chain studied the use of 3D printing of parts required for the assembly of ICU ventilators. It was involved in the development and the equipping of the EMRSSA field hospital. As such, in less than a week, the EMRSSA field hospital was fully equipped with ICU capacities and used three large-capacity oxygen concentrators (Module de Production d’Oxygène Grande Capacité, high-capacity oxygen generator module) producing oxygen at 250 L/min. The French military medical supply chain equipped medical treatment facilities for overseas military operations with increased capabilities of two-bed intensive care modules and supporting the expansion of SARS-CoV-2 tests.

ARMED FORCES BIOMEDICAL RESEARCH INSTITUTE ACTIONS IN THE FIGHT AGAINST THE COVID-19 PANDEMIC

As early as January 2020, the Armed Forces Biomedical Research Institute was working to combat the COVID-19 crisis through scientific literature analysis and medical evaluation and consultation for authorities, especially when French nationals were evacuated from China. When the pandemic severely hit France, the Armed Forces Biomedical Research Institute activities were all redirected towards helping all the FMMS units to cope with the virus. The research response was threefold: (1) set up a larger-scale RT-PCR diagnostic capability; (2) design and conduct several research projects; and (3) help medical care providers by disseminating a literature analysis. Since 11 March 2020, the Armed Forces Biomedical Research Institute helped set up the military training hospital diagnostic RT-PCR capabilities. It also increased its productivity to 800 analysis a day. The Armed Forces Biomedical Research Institute also developed research projects in virology. It was involved in more than 20 research projects directly linked to the pandemic. It helped to select grant proposals for the Defence Innovation Agency. Finally, a task force was set up to more fully engage the Armed Forces Biomedical Research Institute’s workforce and to deliver literature analysis to medical care providers and professional associations. More than 20 reports have been submitted. Teams of the Armed Forces Biomedical Research Institute were tasked with assessing the physiological constraints of several types of modified masks. Some of its biosafety specialists provided consultations and training for donning and doffing personal protective equipment and obtaining nasopharyngeal swab specimen. They delivered biosafety recommendations for aero-MEDEVAC and the EMRSSA field hospital in Mulhouse.

ENGAGEMENT OF FRENCH MILITARY MEDICAL ACADEMY STUDENTS

The students of the French Military Medical Academy have taken part in the fight against the COVID-19 pandemic. All of the academy students volunteered. Cadets in their second to sixth year of medical or pharmacy studies and second-year and third-year nursing students were involved. This deployment across the national territory was their very first military operation. Before deployment, they received information about COVID-19 and appropriate training on how to use the personal protective equipment and how to provide medical care while wearing it. Depending on their level of study, they were employed as stretcher bearers, practical nurses, nurses, medicine or pharmacy students, most of the time in emergency departments or ICUs in the French military training hospitals and in the EMRSSA. Since 24 March 2020, 266 students have been sent to reinforce the military medical treatment facilities, representing 30% of the students of the military academy (42% of students beyond second grade) as of 15 April 2020. Since then, there has been a succession of replacements and reinforcements. This constant adaptation to the changing pressure of the COVID-19 pandemic on the healthcare system is the only way to ensure the sustainability of such reinforcements of caregivers.

CONCLUSION

In an unprecedented medical crisis, the FMMS engaged multiple actions, which are still ongoing, in the fight against COVID-19 in France. Within a global medical system, innovative, dedicated interventions brought together adaptive solutions to issues encountered in the COVID-19 pandemic. Finally, previously highlighted in the National Trauma Care System, military and civilian trauma care systems were integrated to achieve ‘zero preventable deaths after injury’. The collaboration between civilian and military healthcare systems reinforced their shared objective: ‘saving the greatest number of lives’.

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