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Original Research

Ten Years of En Route Critical Care Training

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A B S T R A C T

Objective: The French Military Health Service (FMHS) has developed a training program for medical evacuation (MEDEVAC) of critical care patients on fixed wing aircraft.
Methods: We conducted a 10-year retrospective analysis (2006-2015) of the data from the FMHS Academy. The number of trainees was listed according to the different courses and medical specialties. The number of MEDEVACs recorded during the period was described.
Results: Since 2006, the FMHS has developed training courses designed for MEDEVAC of critical care patients. Forty-five collective strategic MEDEVAC courses were delivered to 91 intensivists, 130 anesthetic nurses, 79 flight surgeons, 55 flight nurses, and 89 nurses. Five sessions of tactical MEDEVAC courses were performed for 14 flight surgeons, 6 flight nurses, and 17 other nurses. Ten sessions of individual strategic MEDEVAC courses were delivered to 17 intensivists, 10 flight surgeons, 21 flight nurses, and 7 other nurses. Between 2006 and 2015, 818 (± 68) individual strategic MEDEVACs were performed per year. Thirty-three (± 19) concerned critical care patients. Five missions of collective strategic MEDEVAC were performed for 56 patients.
Conclusion: The FMHS has developed specific courses for the MEDEVAC of critical care patients, allowing the training of numerous MEDEVAC teams.

To improve care delivered to combat casualties, the French Military Health Service (FMHS) applies a dedicated doctrine with 2 main axes: forward medicalization for damage control resuscitation at ground zero and early strategic air medical evacuation (MEDEVAC) to France for definitive treatment.[1] The North Atlantic Treaty Organization Standardization Agreement 3204,[2] revised in June 2013,[3] defines MEDEVAC as *forward MEDEVAC* from the point of injury to the first medical treatment facility, *tactical MEDEVAC* between 2 medical treatment facilities within the theaters of operation, and *strategic MEDEVAC* for definitive evacuation to France. Evacuation priority is currently defined with priorities 1, 2, or 3, meaning urgent (notice to move < 12 hours), priority (notice to move 12-24 hours), and routine (notice to move > 24 hours) evacuation, respectively. Dependency levels are categorized into 4 levels from D1 to D4 (high, medium, low, and minimal medical requirement). Patients classified as D3 or D4 can be evacuated on regular military flights with an Airbus A340/A310, either alone or accompanied by a flight nurse.

Because of the improvement in the initial survivability of combat casualties, both tactical and strategic MEDEVAC have become increasingly more challenging for air medical crews.[4,5] During MEDEVAC, combat casualties must be stabilized but are not necessarily stable. The air medical environment is very challenging for the delivery of critical care. MEDEVAC teams must be instructed and trained as specialized teams to provide adequate and safe transport of these patients.[6,7] Considering these particular features, the FMHS has developed a specific training program for the MEDEVAC of critical care patients. This article aims to describe the FMHS MEDEVAC training program and its application in the last few

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years, with special insights into the MEDEVAC of critical care patients on fixed wing aircraft.

Methods

Analysis Framework

Tactical MEDEVAC in current sub-Saharan conflicts is characterized by vast areas and long distances.[8] Thus, helicopter tactical MEDEVAC is not possible in this context. Fixed wing tactical MEDEVAC decreases the time for transport to an enhanced role 2 or a role 3.[8] Military cargo aircrafts from the French Airforce (Transall C-160, Hercules C-130, and CASA CN235) are used for tactical MEDEVAC. They can land on short or rudimentary runways. The Transall C-160 and the Hercules C-130 can transport up to 30 patients placed on North Atlantic Treaty Organization stretchers with an air medical crew composed of at least a flight surgeon, a flight nurse, and an additional nurse. An intensivist and/or an anesthetist nurse can reinforce the crew. Up to 4 critical care patients can be transported simultaneously under mechanical ventilation. The CASA CN235 can transport up to 8 patients, with an air medical crew composed of a flight surgeon, a flight nurse, another nurse, and possibly an anesthetist nurse and/or an intensivist nurse.

Individual strategic MEDEVAC of critical care patients in 3 to 6 hours involves Falcon aircraft (900 and 2000) specifically transformed into a MEDEVAC configuration. The air medical crew includes a flight surgeon, a flight nurse, and another nurse. According to the clinical context, an intensivist, a general or specialized surgeon, or a psychiatrist can also complete the crew. The Falcon 2000 uses the Powered Loading System (LifePort Inc, Woodland, WA).

Collective strategic MEDEVAC (about 6-12 casualties) requires MoRPHEE (*Module de Reanimation pour Patient à Haute Elongation d'Evacuation*, or Resuscitation Module for High Elongation Evacuation).[9] This original concept was issued from the collaboration of the FMHS and the French Air Force. MoRPHEE is based on mission-tailored "plug and play" modules, easily and quickly installable aboard a nondedicated aircraft (eg, a Boeing C135-FR strategic tanker). MoRPHEE not only provides the level of care of a flying intensive care unit but also complies with aeronautical security rules.[9] In MoRPHEE, the air medical crew includes 11 personnel: 2 intensivists, 2 flight surgeons, 3 anesthetist nurses, 2 flight nurses, and 2 additional nurses. A 12th seat is dedicated for another specialist (such as a neurosurgeon, psychiatrist, or cardiologist depending on the clinical situation) or a liaison officer in case of a multinational mission.

Administration of the FMHS MEDEVAC Training Programs

The FMHS Academy conducts different training programs, including MEDEVAC. The Aviation Medicine Training Center delivers dedicated courses designed for the MEDEVAC of critical care patients.

The tactical MEDEVAC course for the CASA CN235 focuses on the collective tactical MEDEVAC. This 3-day preparatory course is designed for flight surgeons, flight nurses, and other nurses. It includes both theoretical and practical parts, with an exercise on patient loading and an instruction flight. Simulation sessions are performed during this flight.

The MEDEVAC academic course focuses on the individual strategic MEDEVAC on Falcon aircraft. This 6-hour course is designed for intensivists, flight surgeons, flight nurses, and other nurses. It includes both theoretical and practical components, with an exercise on patient loading using the specific Powered Loading System.

The MoRPHEE application course (a 3-day initial course and a 2-day refresher course) focuses on the collective MEDEVAC for MoRPHEE. An online course is completed before the session. The theoretical part of the session includes the description of the mission, an air medical specific course, and a flight security course. During the practical part, the trainees must implement the modules on board and learn and repeat exercises of oxygen and electrical security procedures. The course is completed by an instructional flight with onboard simulation sessions and security exercises.

Data Collection

Records from the FMHS Academy and the Aviation Medicine Training Center have been examined and analyzed since 2006. The total number of courses and trainees was listed regarding the corresponding operational activity. The results are described in the following order: tactical MEDEVAC, individual strategic MEDEVAC, and collective strategic MEDEVAC. Data are expressed in values and means (± standard deviation).

Results

Training Programs

The tactical MEDEVAC course for the CASA CN235 was created in 2014. The FMHS Academy organized a total of 5 sessions for 14 flight surgeons, 6 flight nurses, and 17 other nurses. For the MEDEVAC academic course, which was created in 2015, a total of 10 sessions were delivered to 17 intensivists, 10 flight surgeons, 21 flight nurses, and 7 other nurses.

The MoRPHEE application course was created in 2006 in which 45 courses were delivered to 91 intensivists, 130 anesthetic nurses, 79 flight surgeons, 55 flight nurses, and 89 other nurses. These results are summarized in Table 1. International MoRPHEE application courses were structured for German, Dutch, and Belgian air medical crews in 2012 and 2015. The online course to be completed before the MoRPHEE application course was created in 2014. Sixty trainees completed this course: 25 for the initial course and 35 for the refresher course. Moreover, a total of 38 simulations sessions were performed on board, either on a CASA or Boeing C135-FR (Figs. 1 and 2). Tables 2 and 3 present the curricula of the tactical MEDEVAC and MoRPHEE application courses.

Operational Activity

Since the beginning of sub-Saharan military operations (Serval and Barkhane) in January 2013, French CASA CN235 aircrafts have been available within the area of operation for individual or collective tactical MEDEVAC. Between January 2013 and December 2015, 324 collective tactical MEDEVACs allowed the transportation of 571 patients. In the meantime, between 2006 and 2015 (520 weeks), a complete air medical crew was on duty 7 days a week in Paris for individual strategic MEDEVACs of critical care patients. During this period, a mean of 818 (± 68) individual strategic MEDEVACs were performed per year, and a mean of 33 (± 19) concerned critical care patients. During the same period (520 weeks), a complete air medical crew was on duty 7 days a week for the MoRPHEE collective strategic MEDEVAC. During this period, 5 missions of MoRPHEE were performed, allowing the strategic MEDEVAC of 56 patients.

Discussion

Our work characterizes the FHMS training programs for medical teams designed to facilitate the MEDEVAC of critical care patients during the last 10 years. Basically, our analysis highlights the development of new tools for training in critical care during MEDEVACs on fixed wing aircraft. In the past decade, experience from combat casualties care in Iraq and Afghanistan led to numerous revisions of combat injury management.[10] The chain of survival begins with tactical combat casualty care, including forward medicalization and early damage control surgery.[11] Forward, tactical, and strategic MEDEVAC are essential to prolong improvement of the survivability of combat casualties.[12] En route care requires the maintenance of a high level of care and security.[10] To