Five years of prolonged field care: prehospital challenges during recent French military operations

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BACKGROUND: French military operations in the Sahel conducted since 2013 over more than 5 million square kilometers have challenged the French Military Health Service with specific problems in prolonged field care.

STUDY DESIGN AND METHODS: To describe these challenges, we retrospectively analyzed the prehospital data from the first 5 years of these operations within a delimited area.

RESULTS: One hundred eighty-three servicemen of different nationalities were evacuated, mainly as a result of explosions (73.2%) or gunshots (21.9%). Their mean number evacuation was 2.2 (minimum, 1; maximum, 8) per medical evacuation with a direct evacuation from the field to a Role 2 medical treatment facility (MTF) for 62% of them. For the highest-priority casualties (N = 46), the median time [interquartile range] from injury to a Role 2 MTF was 130 minutes [70 minutes to 252 minutes], exceeding 120 minutes in 57% of cases and 240 minutes in 26%. The most frequent out-of-hospital medical interventions were external hemostasis, airway and hemopneumothorax management, hypotensive resuscitation, analgesia, immobilization, and antibiotic administration. Prehospital transfusion (RBCs and/or lyophilized plasma) was started three times in the field, two times during helicopter medical evacuation, and five times in tactical fixed wing medical aircraft. Lyophilized plasma was confirmed to be particularly suitable in these settings. One of the specific issues involved in lengthy prehospital time was the importance to reassess and convert tourniquets prior to Role 2 MTF admission.

CONCLUSION: Main challenges identified include reducing evacuation times as much as possible, preserving ground deployment of sufficiently trained medics and medical teams, optimization of transfusion strategies, and strengthening specific prolonged field care equipment and training.

The implementation of Tactical Combat Casualty Care, reduced prehospital transport time, and a comprehensive damage control strategy are some of the elements that have resulted in an unprecedented decrease in combat casualty mortality during the Iraqi and Afghan conflicts.[1–3]

ABBREVIATIONS: CASA = fixed wing medical tactical aircraft; FLYP = French lyophilized plasma; FMHS = French Military Health Service; MEDEVAC = medical evacuation; MTF = medical treatment facility; PECC = patient evacuation coordination cell.

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Since 2013, the French Military Health Service (FMHS), like those of several other nations, faces new constraints that include the support of light footprint operations spread over five countries (Mauritania, Mali, Burkina Faso, Niger, and Chad) and a 5 million-square-kilometer area (more than one-half the area of the United States) with an unavoidable lower concentration of helicopters and surgical capabilities.

Classically defined as field medical care applied beyond doctrinal planning timelines, prolonged field care has been the focus of much attention in recent years.[4–7] The objective of this article is to describe prehospital care and specific casualty management difficulties encountered in this context.

METHODS

Context

The medical support of current operations is based on a damage control strategy started in the field and continued throughout the evacuation, including:

- Combatants trained in "combat rescue," the French equivalent of Tactical Combat Casualty Care.[8,9]

- Combat medics trained in "Level 2 combat rescue".[8,9] They are nonmedical personnel who receive enhanced medical training beyond the level of self-aid or buddy-aid, focused on bleeding management including venous and intraosseous access, tactical tourniquet assessment, and airway and respiratory management including pneumothorax decompression and cricothyroidotomy.

- Physicians and nurses forward deployed and often fully embedded with combat units, also trained in combat rescue,[8] and frequently proficient in emergency medicine.

- Forward medical evacuation (MEDEVAC) helicopters with at least an emergency physician and nurse on board.

- Fixed wing medical tactical aircraft (CASA CN-235) with an emergency physician, two nurses (including one flight nurse), and a support capacity of eight casualties, including two critically wounded.[10]

- Forward surgical units (Role 2) including a general surgeon, an orthopedic surgeon, an anesthesiologist, two anesthetist nurses, an operating room nurse, two nurses, an administrative noncommissioned officer, and three medics.[11]

- Strategic medical evacuation by Falcon aircraft. Falcon 900 and Falcon 2000 are both long-range jets able to join the center of Africa (Chad, Mali) in an 8-hour flight without refueling. They are able to repatriate patients at an early stage to military teaching hospitals in France, which is consistent with the French strategy to perform only damage control surgery in the field and primary surgery as early as possible in France. Their crew usually includes an emergency physician, a flight nurse, and a nurse. This crew can be reinforced by an anesthesiologist for acute care patients, and occasionally by a surgeon when a special surgical capability is needed (e.g., neurosurgery). The aircrafts are equipped to be able to provide the full range of intensive care, but in-flight surgery is not possible.

- Military teaching hospitals in France (Role 4), which include several trauma centers specialized in combat casualty care.

The difficulties caused by distances of sometimes over 1000 kilometers between the point of injury and surgical teams, and the need to transfer casualties after surgery to international airports for strategic evacuations, have justified the deployment of fixed wing medical tactical aircraft (CASA) in addition to MEDEVAC rotary wing platforms.[12] The procedures have also been gradually adapted to the constraints of the field, including the establishment of a comprehensive prehospital transfusion program.[12–15]

Study design

This was a retrospective study with analysis of all data archived by the patient evacuation coordination cell (PECC), completed by those extracted from forward and tactical MEDEVAC (helicopters and CASA), strategic medical evacuation, and hospital records.

Inclusion criteria and data collected

All soldiers killed or wounded in combat-related actions and treated by the FMHS between January 1, 2013, and January 31, 2018, within a delimited area of Sahel operations were included. The specific locations and nature of these operations are not specified for operational security reasons.

Data collected included age, sex, the nature of injuries, triage data, the timeline of each MEDEVAC (from field operational commander request to admission in a Role 4 hospital), medical data at each stage of evacuation, difficulties encountered according to the PECC, MEDEVAC, and hospital records.

Results are presented as numbers (percent), means (standard deviation), and medians with interquartile ranges [25th and 75th].

Definitions

The categorization of casualties in the field is based on NATO's classification: Alpha for those needing medical or surgical intervention in less than 90 minutes, Bravo for those requiring intervention within 4 hours, and Charlie for those who can wait up to 24 hours for evacuation.[12,16]

The definitions used for the follow-up of casualties (killed in action, wounded in action, died of wounds, returned to duty, and case fatality rate) are those recommended by Holcomb et al.[17] and frequently used in the literature.

RESULTS

A total of 183 military combat-related casualties of different nationalities were managed by the PECC and treated by the FMHS during this 5-year period within the defined study area.

Contexts and types of injury

The characteristics and follow-up of the 183 casualties are reported in Table 1. The main mechanism of injury was explosion caused by improvised explosive device. The injuries most often involved extremities, with an average of 1.7 injured areas per casualty.

The number of casualties per MEDEVAC request ranged from 1 to 8, with an average of 2.2 wounded per event.

Prehospital medical care of Alpha and Bravo casualties

Prehospital medical care in the field was performed by a physician for 80% of casualties. For 10 casualties, the access of medical teams was delayed due to the tactical context, with a delay of over 1 hour for three casualties.

When the initial location of medical care for casualties was known (N = 34), the following locations were observed: the field with direct evacuation to a Role 2 medical treatment facility (MTF) (62%); the field to a Role 1 MTF for evacuation (15%); and Role 1 MTF as the first location of care (23%).

TABLE 1. Demographics and characteristics of 183 combat casualties

Mean age (SD)	28 (6)
Median [IQR]	27 [23–31]
Male sex	180 (98.4%)
Mechanisms of combat injury	
Gunshot	40 (21.9%)
Explosion	134 (73.2%)
Helicopter crash	3 (1.6%)
Other injury	6 (3.3%)
Wound distribution recorded by prehospital providers (available data for 169 casualties)	
Upper limb	40 (23.4%)
Lower limb	62 (36.7%)
Pelvis and junction	19 (11.2%)
Head and neck	44 (26%)
Thorax	20 (11.8%)
Abdomen	17 (10.1%)
Spine	16 (9.5%)
Soft tissues	11 (6.5%)
Auricular blast	51 (30.2%)
Burn injury	7 (4%)
Number of wounded regions per casualty	1.8 ± 1.3
Outcomes	
Killed in action (KIA)	11 (6%)
% KIA among non-RTD casualties	*9.1%*
Wounded in action:	172 (94%)
• Return to duty <72 h	62 (36%)
• Admitted in Role 2 MTF and evacuated	103 (59.9%)
• Died of wounds	7 (4.1%)
% DOW among non-RTD WIA	*6.4%*
Case fatality rate	9.8%

Data expressed as number (percentage), mean +/− SD or median [IQR].
CFR = case fatality rate (KIA + DOW / KIA + WIA); DOW = died of wounds (after reaching a military medical treatment facilities); IQR = interquartile range; KIA = killed in action (before reaching a military medical treatment facility); MTF = medical treatment facility; RTD = return to duty within 72 hours; WIA = wounded in action.

TABLE 2. Field triage and follow-up by categorization

Field initial categorization	
Killed in action	11 (6%)
Alpha casualties	46 (25.1%)
Bravo casualties	32 (17.5%)
Charlie casualties	94 (51.4%)
Follow up of the 46 *Alpha* casualties	
Median [IQR] injury severity score	20 [16–41]
Died of wounds	7 (15.2%)
Admitted in Role 2 MTF and evacuated	36 (78.3%)
Return to duty <72 h	3 (6.5%)
Follow up of the 32 *Bravo* casualties	
Median [IQR] injury severity score	9 [7–13]
Died of wounds	0
Admitted in Role 2 MTF and evacuated	26 (81.3%)
Return to duty <72 h	6 (18.7%)
Follow up of the 94 *Charlie* casualties	
Median [IQR] injury severity score	4 [3–4]
Died of wounds	0
Admitted in Role 2 MTF and evacuated	41 (43.6%)
Return to duty <72 h	53 (56.4%)

Data expressed a number (percentage) and median [IQR].
IQR = interquartile range; MTF = medical treatment facility.

The initial categorization of Alpha, Bravo, or Charlie groups was performed by medical teams in the field before evacuation to a Role 2 MTF, and the outcome of the casualties by category are reported in Table 2.

Prehospital data for Alpha and Bravo casualties are reported in Table 3. The most frequent lifesaving interventions performed in the field and during evacuation were external hemostasis, airway and hemopneumothorax management, hypotensive resuscitation, analgesia, immobilization, and antibiotic administration.

A total of 31 tourniquets were placed on 18 casualties due to multiple injuries or sometimes due to the ineffectiveness of the first tourniquet. For three casualties, the tourniquet initially placed could be loosened and converted into a compression bandage prior to evacuation. For the others, withdrawal could only be performed in a Role 2 MTF after a median time of 90 minutes [62 minutes to 262 minutes], which was longer than 120 minutes for six casualties due to the duration of evacuation (Table 3 and Fig. 1). Complications possibly related to ischemia (rhabdomyolysis, compartment syndrome) were described for four casualties with a tourniquet time longer than 120 minutes, and for none when the tourniquet had been loosened in less than 120 minutes.

Compromised airway in the prehospital setting was described for six casualties. Simple airway intervention such as suction or sitting position was considered sufficient for four casualties. Orotracheal intubation and cricothyroidotomy were each performed once. Three other casualties were intubated just prior to MEDEVAC due to impaired consciousness (Glasgow Coma Scale ≤8).

Prehospital transfusion with lyophilized plasma and/or RBCs has been possible since 2016 for prehospital FMHS teams. Among these casualties, transfusion was initiated a total of three times in the field, two times during helicopter

TABLE 3. Alpha and Bravo casualties: field treatments before Role 2 MTF admission

N = 78; sufficient prehospital available data for N = 56	
Hemorrhage control	
Tourniquet	
• Number of casualties with tourniquet	18 (14.3%)
• Number of tourniquets used	31
• Upper limb/lower limb	6/25
• Median tourniquet time	90 min [62–262]
• Casualties with tourniquet time >120 minutes	6 (10.7%)
Casualties with hemostatic packing*	13 (23.2%)
SAM junctional tourniquet	1 (1.8%)
Pelvic binder	13 (23.2%)
Skin suture	2 (3.6%)
Use of urinary catheter for tamponade of massive epistaxis	1 (1.8%)
Airway or breathing distress	19 (34)
Orotracheal intubation	5 (8.9%)
• Airway obstruction	1 (1.8%)
• Coma	4 (7.1%)
Cricothyroidotomy	1 (1.8%)
Chest dressing	7 (12.5%)
Pneumothorax needle decompression or thoracostomy	3 (5.4%)
Thoracic drainage	3 (5.4%)
Peripheral intravenous access*	38 (67.9%)
Intraosseous access	3 (5.4%)
Resuscitation	19 (34%)
FLYP	9 (16.1%)
Red blood cell	4 (7.1%)
Fibrinogen	3 (5.4%)
Tranexamic acid*	20 (35.7%)
Hypertonic saline	14 (25%)
Hydroxyethyl starch	6 (10.7%)
Vasopressors	10 (17.9%)
Analgesia*	
Paracetamol/nefopam	9 (16.1%)
Morphine (SC and IV)*	29 (51.8%)
Field median dose (mg)	7.5 [4.7–14]
MEDEVAC median dose (mg)	3.5 [3–5]
Ketamine (IV)	11 (19.6%)
Median prehospital dose (mg)	50 [20–50]
Midazolam (IV)	7 (12.5%)
Median prehospital dose (mg)	2 [2–2]
Spine immobilization before MEDEVAC*	10 (17.9%)
Amoxicillin/clavulanic acid *	29 (51.8%)

Data expressed a number (percentage) and median [IQR].
* Likely not exhaustively reported.
IV = intravenous; FLYP = French lyophilized plasma; MEDEVAC = medical evacuation; SC = subcutaneous.

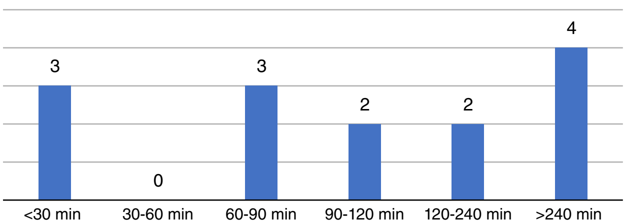

Fig. 1. Number of casualties by tourniquet time (available data for N = 14).

TABLE 4. Locations of transfusion (number of blood products delivered)

	Plasma	RBCs	Fibrinogen	Whole blood
Field	3	0	0	0
HM MEDEVAC	4	1	0	0
CASA MEDEVAC	5	3	3	1
Role 2 MTF	63	75	24	28
Falcon STRATEVAC	3	2	0	2

CASA = fixed wing medical tactical aircraft; HM = Rotary wing tactical aircraft; MEDEVAC = medical evacuation; MTF = medical treatment facility; STRATEVAC = strategic medical evaluation.

MEDEVAC, and five times during CASA flights (Table 4). The failure to reconstitute lyophilized plasma was described in one case. No transfusion complications have been reported.

The 20 casualties transfused in Role 2 MTFs then received each an average of 3.1 RBC units, 3.75 plasma units, 1.8 g of fibrinogen, and 1.4 bags of type-specific fresh whole blood collected on site by colocalized Role 1 medical teams.

Evacuation procedures and durations

Table 5 reports the evacuation procedures and durations for the 46 Alpha casualties.

Helicopter was the most frequently used "en route care" platform (N = 40), with the possibility to land close to casualty location according to tactical conditions.

TABLE 5. MEDEVAC time frame for 46 Alpha casualties

Median time from injury to Role 2	130 min [70–252]
MEDEVAC time > 120 min	26 (57%)
MEDEVAC time > 240 min	12 (26%)
Median time from injury to Role 2 MTF based on context and organizational issues:	
• Ground transportation (N = 4)	22 min [16-31]
• Rotary wing (N = 29)	125 min [70–142]
Time from injury to take off (rotary wing)	32 min [15–42]
Time on point of injury (rotary wing)	7 min [1–14]
Flight time from POI to Role 2	30 min [23–50]
• Rotary wing followed by fixed wing (N = 11)	315 min [252–333]
• Ground followed by fixed wing (N = 2)	380 min [380–380]
Median (IQR) time from injury to arrival in Role 4 hospital	25 h [23-34]

Data expressed as number (percentage) and median [IQR].
MTF = Medical treatment facility, IQR = interquartile range; MEDEVAC = medical evacuation; MTF = medical treatment facility; POI = point of injury.

For some long-distance evacuations, CASA aircraft saved time due to their flight speed and greater autonomy; however, these aircraft required the availability of a suitable landing strip. The combination of helicopter and then CASA aircraft was used for the long-distance forward MEDEVAC of 11 casualties, with a median evacuation time of 315 minutes [252 minutes to 333 minutes].

Overall, the "point of injury to Role 2" time was longer than 120 minutes for 57% of casualties and over 240 minutes for 26%.

For French soldiers, the median time between injury and admission to one France's Role 4 military teaching hospitals was 25 hours [23-34 hours] for Alpha casualties.

Two cases of sepsis were reported in hospital records. Five pulmonary emboli were diagnosed during computed tomography scans (two upon admission).

Overall, 6% of casualties were killed in action (9.1% of all patients not returned to duty within 72 hours). The died-of-wounds rate (patients who died after admission to an MTF) was 4.1% (6.4% of patients not returned to duty within 72 hours; Table 1).

DISCUSSION

This study describes the treatment of 183 combat casualties by the FMHS over 5 years in a 5 million-square-kilometer joint operation area. The difficulties encountered are similar to those already described by other teams facing similar situations[1,4,5] and remind us of some relevant aspects to consider.

The platinum 5 minutes, access to casualties, triage, and lifesaving interventions

Most prehospital lifesaving interventions must be performed within the initial minutes following the injury.[15,16] This challenge is obviously not specific to prolonged field care, but the spread of increasingly small teams over an increasingly large territory makes the simultaneous presence of fully trained staff embedded with each small unit more complex, albeit more crucial.

Field data collected for our study did not allow us to accurately measure tactical access times to casualties, nor to assess the quality of interventions performed in the initial minutes following injury. Specific "forward medical register sheets" have been distributed since 2009 to prehospital medical teams to enhance collective debriefing after action and to improve prehospital data collection. Unfortunately, only 28 of these sheets were stored and available for analysis in this study.

The killed in action rate (9.1%) was lower than or similar to other operations.[3,16] Nevertheless, difficulty in gaining access to begin tactical combat casualty care interventions due to the tactical context was reported for 10 casualties. This observation highlights the importance of comprehensive combat rescue training for all medical and nonmedical personnel, with the integration of medical and tactical issues into commander decisions and shared consideration regarding the appropriate level of security to expect before each casualty extraction.[8,9]

The initial patient triage categorization as performed by forward medical teams seems appropriate, as no deaths occurred secondarily among Bravo or Charlie casualties, while only 6% of Alpha casualties returned to duty within 72 hours.

The average number of 2.2 casualties per event is a known issue. As such, field medical teams must simultaneously manage several victims, frequently with limited resources, because they are distant from Role 1 MTF infrastructure in 77% of cases.

The "tyranny of distances" and the importance of maintaining acceptable evacuation times

Despite the permanent deployment of at least three forward surgical teams, the distribution of helicopters in the theater, and the addition of two CASA aircraft specifically dedicated to MEDEVAC, the median distance between the point of injury and Role 2 MTFs was 290 kilometers over the 2013–2016 period.[12]

In the present study, the median time from injury to Role 2 MTFs of 130 minutes for Alpha casualties is in the range of the 145 minutes reported by Carfantan et al.[12] for all "Serval" and "Barkhane" operation MEDEVAC missions, which included medical diseases and battle or nonbattle injuries. However, a total of 57% of Alpha casualties arrived at Role 2 MTFs after more than 120 minutes following injury, while 26% arrived at Role 2 MTFs after 240 minutes.

These time frames contrast with those previously described in Afghanistan, where evacuation times were mostly less than 60 minutes with a calculated benefit of 1.4% of killed in action (equivalent to 135 deaths) when MEDEVAC length decreased from 90 to 60 minutes for the US forces.[2]

Increasing the number of aircraft and distributing them throughout the theater would certainly reduce the access time to surgical facilities, but this strategy—although highly justified—faces logistic constraints in an area much larger than Afghanistan.

While continuing efforts to reduce forward MEDEVAC time frames, several authors reported a positive impact of the level of care delivered in the field and then during MEDEVAC.[18–24] The deployment of medical teams in the field, and in aircraft, has been particularly developed by the FMHS. In addition to the presumed technical benefit for some critical injuries, the contact between field teams, the PECC, MEDEVAC physicians, and Role 2 MTFs seemed relevant to guide prehospital care before delayed evacuations or to optimize the use of land and air MEDEVAC to fit each specific situation.

For 12 casualties in this study, international collaborations allowed a reduction in time between injury and surgery.

Optimization of prehospital transfusion strategies

Consistent data support the benefit of prehospital transfusion.[2,3,25–28] Delayed evacuation further reinforces the importance of blood products being available closer to the site of injury and during evacuation, which justifies the provision of French lyophilized plasma (FLYP) for ground Role 1 medical teams and the transfusion of plasma and RBC during MEDEVAC since 2016.[13,14]

Vitalis et al.[13] described that 25% of Alpha casualties received prehospital transfusion in a similar area of operations between April 2016 and April 2017. Our series also confirms the easy utilization of FLYP in the field.

Manufactured by the FMHS, FLYP is particularly suitable for remote and austere settings, as it can be stored at ambient temperature for 2 years (even in hot environments), then reconstituted in less than 6 minutes, while being universal for all blood groups.[14,29] In the present study, one failure to reconstitute FLYP highlighted the importance of predeployment medical training. An ongoing multicenter study is currently evaluating FLYP prehospital benefits in civilian trauma,[30] and its use has recently been authorized by the US Food and Drug Administration.[31]

When dispatched from a Role 2 platform, each helicopter and CASA aircraft carries at least two units of RBCs. Since the end of this study, new procedures have allowed the forward cold storage of RBCs, even when MEDEVAC teams are away from Role 2 MTFs, which enables the rotation of RBCs between Role 2 and prehospital teams to avoid blood component wasting.

Current FMHS guidelines also include on-site collection of "warm" fresh whole blood from prescreened donors.[15,32–34] In our series, this procedure was used in Role 2 MTFs for seven casualties, with blood collection being performed by colocated Role 1 teams. No prehospital whole blood collection was described during our study, though it was regularly performed in other contexts and is likely relevant for use in remote areas.[15] Since 2016, specific instructions have been added to the predeployment training of nurses and physicians to enhance the training of prehospital teams for minimizing the time between blood collection and transfusion and, above all, to prepare them to concurrently manage several casualties and whole blood collections on the ground.

The next step is likely the provision of cold stored low titer and leukoreduced group O whole blood collected in France for use in MEDEVAC and occasionally by ground teams.

Preparing prehospital teams for the specific challenges of prolonged field care

The skill sets for teams confronted with caring for casualties beyond doctrinal time frames have been described by the Special Operations Command Prolonged Field Care Working Group.[4] For example, the prolonged management of traumatic brain injury or hemorrhagic shock requires a much greater level of technical skill than what is taught in classical combat rescue courses. This makes it necessary to adapt initial and maintenance training, allowing all medical staff to practice regularly between deployments in hospital and prehospital emergency services to enhance and maintain their skills.

A clearly identified issue in our series (Table 3 and Fig. 1) relates to the reassessment and conversion of tourniquets. While the benefits of rapid and liberal use of tourniquets in the initial phase of hemorrhage management is well documented,[18,35,36] the lengthening of evacuation times also highlights the critical importance of reassessing each tourniquet as soon as possible, and whenever possible beyond 2 hours to avoid ischemic complications.[37] Current French and international guidelines recommend reassessing tourniquets as soon as the tactical situation allows it, and whenever possible to convert it to a simple local hemostatic packing. The only conversion contraindications are for shocked patients, to avoid worsening shock in the case of rebleeding, amputated limbs, or, for some, a delay of over 6 hours following injury; however, the exact limit is still a matter of debate.[38] The systematic application of a loose additional tourniquet before conversion is recommended to secure the conversion procedure.[37]

Field analgesia or wound management has also become challenging as the time frame to definitive care lengthens.[39,40] Multimodal analgesia combining subcutaneous then intravenous morphine,[41] ketamine, and midazolam were used during our study according to the current French guidelines (Table 3). Intranasal administration of analgesics (fentanyl, ketamine) is also increasingly used in the field. The wider use of locoregional anesthesia could be considered but requires sufficient training and equipment.[39]

Adapting the equipment of field and MEDEVAC teams

The "Ruck-Truck-House-Plane" approach proposed by Mohrand Keenan[42] to describe the logistic context of prolonged field care applies perfectly to the constraints that we encountered.[4]

When deployed dismounted, medics, nurses, and physicians may include medical products and drugs in limited quantities in their equipment. Increasingly miniaturized monitoring devices, including capnometers, stretchers, and blood collection kits, have been specifically adapted to these conditions.

Oxygen, respirators, splints, and fluids in larger quantities are most often available in medicalized vehicles and the Role 1 MTF infrastructure. Role 1 MTFs are convenient when the casualty is nearby; however, 62% of casualties during our study were evacuated directly from the field to Role 2 MTFs, which justifies ongoing work on future medical vehicles, the miniaturization of devices for monitoring or oxygen therapy, or pharmaceutical storage in extremely hot or cold environments.

MEDEVAC helicopters and aircraft are fully equipped for prehospital resuscitation, and in some cases are able to resupply ground teams while evacuating a patient.

Isolation and longer periods of care in austere settings further strengthen interest in field ultrasound capability to guide diagnosis and intervention. Similarly, it is likely that point-of-care laboratory tests (including lactate or coagulation, for example) could help to better guide remote damage control resuscitation.[32]

In addition, current MEDEVAC flight durations encourage ongoing research on the potential benefit of advanced hemostatic interventions to temporarily control truncal hemorrhaging until arrival at Role 2 MTFs such as resuscitative endovascular balloon occlusion of the aorta.[43]

Finally, the reassessment of casualties over several hours would be facilitated by extra tools in addition to the classical forward medical paper forms to improve recording of clinical signs and therapies over a long period.[44]

Role of telemedicine

Telemedicine is 1 of the 10 capabilities to be considered for prolonged field care[4,45] and constitutes an intuitive response to the difficulties posed by distance.

Interest in guiding the forward management of medical diseases or to discuss issues in a multidisciplinary manner between specialists in the field and at Role 4 hospitals is frequently reported by deployed military practitioners.

However, in our experience, the contribution of telemedicine to the prehospital care of critical casualties is much more moderate and unable to replace ground personnel expertise. The nature and severity of injuries, frequent mass casualty situations, and the constant improvement of field care possibilities support our strategy of deploying forward enough well-trained medics and medical teams specifically prepared for prolonged field care.

Limitations of the study

Our study does not reflect the entire scope of activity for Role 1 medical teams and does not describe medical diseases or nonbattle injuries, which account for 98% of Role 1 activity, according to institutional epidemiologic data.

Furthermore, retrospective prehospital data collection in the military context remains challenging. Many prehospital interventions were missing or incompletely reported in the documents we analyzed. Important work is underway in the FMHS to enhance data collection in the field and to implement a reliable casualty registry; however, the absence of this tool in previous years remains a limitation for the present study.

The number of casualties included and the overall paucity of data concerning precise causes of death do not allow us to study the link between prehospital interventions and mortality. Finally, our study focused on the "en route care" and suffers from a lack of data on the care provided before the start of the MEDEVAC.

Due to the aforementioned limitations, some measured prehospital data should likely be interpreted with caution (as indicated in Table 3).

CONCLUSION

The medical support of current French military operations, over an area of 5 million square kilometers, challenges FMHS prehospital teams with specific medical and logistic issues.

Capability gaps identified include reducing evacuation times as much as possible, preserving ground deployment of sufficiently trained medics and medical teams, optimization of transfusion strategies, and strengthening specific prolonged field care equipment and training.

CONFLICT OF INTEREST

The authors have disclosed no conflicts of interest.

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