

# Prolonged Casualty Care, during Serval and Barkhane operations: capability gaps and training issues. What are the challenges of Prolonged Casualty Care on the battlefield, based on the experience of the French medical service in the Sahel?

« Prolonged Casualty Care » pendant les opérations Serval et Barkhane: écarts de capacité et problèmes d'entraînement. Quels sont les défis du "Prolonged Casualty Care" sur le terrain, basé sur l'expérience du service de santé Français au Sahel ?

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## Abstract

From 2013 to 2022, the French military medical service supported the French armed forces during the Serval and Barkhane operation in the Sahel over a 5 million square kilometer area. A low concentration of MEDEVAC helicopters and remote surgical medical treatment facilities required the French medical service to do more than Tactical Combat Casualty Care in the field and practice Prolonged Casualty Care. Several studies have highlighted important aspects of the prehospital care performed by the French military medical teams during operations in the Sahel, with room for continuous improvements: better tourniquet management with reassessment in the field and a greater availability of blood products. Interestingly, medical teams expressed a desire for more dedicated training in Prolonged Casualty Care. The use of new technologies, including telemedicine, could be widespread in the future to better conduct challenging medical procedures in real time. In any case Prolonged Casualty Care, defined in minimal, better, and best options can be provided whether in ruck, truck, house or plane, with limited resources and a hostile environment.

**Key words:** Prolonged Casualty Care, Prolonged Field Care

## Résumé

De 2013 à 2022, le service de santé des armées Français a accompagné les forces armées Françaises dans le Sahel pendant les opérations Serval et Barkhane avec un terrain s'étendant sur plus de 5 millions de kilomètres carrés. Le faible nombre d'hélicoptères MEDEVAC et l'éloignement des infrastructures médico-chirurgicales ont poussé le service de santé français à aller plus loin que le « Tactical Combat Casualty Care » en pratiquant le « Prolonged Casualty Care ». Plusieurs études ont souligné certains aspects importants de la prise en charge pré-hospitalière effectuée par le service de santé des armées français pendant les opérations au Sahel, avec des améliorations toujours possibles : une meilleure utilisation des garrots avec une réévaluation plus précoce sur le terrain et une plus grande disponibilité des produits sanguins. Afin de progresser, les équipes médicales ont exprimé le désir d'avoir une formation plus poussée sur le thème du « Prolonged Casualty Care ». L'utilisation des nouvelles technologies, comme la télémédecine, pourrait à l'avenir se répandre et faciliter en temps réel la réalisation de procédures médicales parfois difficiles. En tout état de cause, le « Prolonged Casualty Care » dans ses diverses options qu'elles soient minimales, bonnes ou meilleures peut être pratiqué que ce soit dans la brousse, dans un véhicule, dans une maison ou dans un avion avec des ressources limitées et dans un environnement hostile.

**Mots clés :** Réanimation de l'avant, Soins Critiques Prolongés

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## Introduction

Over the last twenty years, through the medical experience in Middle East and Sahel conflicts, it has been well established that to save more lives of combat casualties

on the battlefield, the priority was to perform damage control resuscitation and surgery as soon as possible [1]. Getting to a medical treatment facility with resuscitation and surgical capabilities in less than an hour was associated with a significant re-

duction in mortality and morbidity [2][3]. But this *golden hour* principle was established for kinetic asymmetric and unconventional conflicts with guarantees of air superiority and rapid evacuation time [4]. Some may argue that that this doctrine is hardly applicable in new or future conflicts in which such conditions are not guaranteed. Furthermore, the *golden hour* works in synergy with Tactical Combat Casualty Care (TCCC). TCCC is a set of best pre-hospital military lifesaving interventions used to stabilize the patient while waiting for a Tactical or Medical Evacuation. It may include for example the use of tactical tourniquet and forward transfusion. the combined use of tactical tourniquet, forward transfusion and the *golden hour* is associated with a threefold increase in survival [5]. Therefore, the North Atlantic Treaty Organization (NATO)'s guideline for special operation forces medical support has integrated both the TCCC and the *golden hour* [6]. But what if the golden hour principle cannot be met because of the loss of superiority over the enemy, especially air superiority, which facilitates medical evacuations in less than an hour. This is the case, for example, for special operations forces, which operate in all regions of the world and on a wide variety of missions, in particularly hostile environments, far from a security zone controlled by the allies [7]. In these operations, the extraction of casualties is therefore complex, requires more time, and TCCC will not be enough to manage combat casualties for a prolonged period [8]. Facing this challenge, the application of Prolonged Casualty Care could be an auspicious solution. Prolonged Casualty Care is defined as "*Field medical care, applied beyond 'doctrinal planning time-lines' by a Special Operations Combat Medic or higher, in order to decrease patient mortality and morbidity. Utilizes limited resources, and is sustained until the patient arrives at an appropriate level of care*" [9]. To put it in other words, Prolonged Casualty Care is just like "*holding a patient sicker than you can care for, for longer than you want with fewer resources than you need, in a place you do not want to be*" [10]. Thus, Prolonged Casualty Care does not replace TCCC, but it is a continuation of it [11]. Prolonged Casualty Care comes together with TCCC and Damaged Control procedures. It implies that Prolonged Casualty Care is also conducted during medical evacuations, until the combat casualties have reached a medical treatment facility with a higher level of care. Some authors have described also the

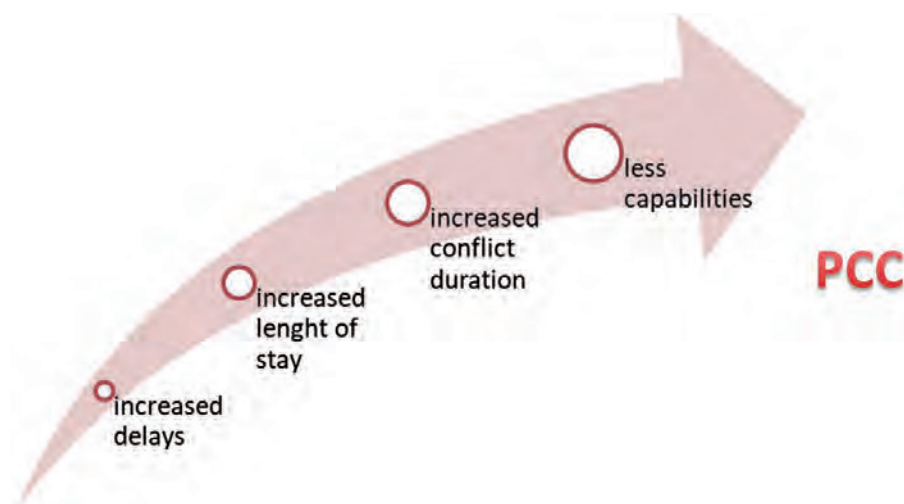


Figure 1: Modification of the casualties' care due to conflicts evolution

Prolonged Field Care. Prolonged Casualty Care and Prolonged Field Care define the same process, but Prolonged Field Care was originally for the Army. To include the Navy, who is not on the field, it was decided to switch from Prolonged Field Care to Prolonged Casualty Care. [12] This narrative review aims to measure the challenges of Prolonged Casualty Care on the battlefield, based on the experience of the French medical service in the Sahel.

#### Experience of the French military medical service in Serval and Barkhane operations

In the medical doctrine of the French armed forces, a medical team is deployed as close as possible to the point of injury. This has many several benefits. First, it means that many high-level medical procedures can be performed at an early stage [13]. Then, the physician can get a clear and direct view of the situation and organize either tactical or medical evacuation. Finally, the physician has sufficient perspective and medical background to provide adequate medical procedures, depending on the type of casualty, the level of resources he has on the field and the time before evacuating the casualty. In this context, the French military medical service operated during the Serval and Barkhane operation in the Sahel since 2013 and 2014 respectively. The French armed forces were deployed in a 5 millions square kilometer area, more than one half the area of the United States over five countries (Mauritania, Mali, Burkina Faso, Niger, and Chad). The French military medical service supported armed forces with a low concentration of helicopters and remote access to surgical capabilities [14]. Medical evacuations in such large areas were associated

with major logistical and human challenges.

#### Increased evacuation time

A retrospective study from Carfantan C *et al* from 2013 to 2016 analyzed 533 medical evacuations from the point of injury to a Role 2 [15]. It found out that the median time from the point of injury to a Role 2 for ALPHA patients (the most severe ones) was 145 minutes;interquartile range (IQR) :100 - 251.

Another retrospective study by Travers *et al* analyzed five years of prehospital data from the French military operation in the Sahel [14]. In this study, the median time from the point of injury to a Role 2 for 46 ALPHA combat casualties was 130 minutes (IQR 70 - 252). 57% of the medical evacuations were exceeding 120 minutes and 26% were exceeding 240 minutes. The authors of these two studies concluded that, ALPHA patients time frame was longer than the *golden hour* recommended by the North Atlantic Treaty Organization. Finally, it means that, in the Sahel the French military medical teams had to conduct Prolonged Casualty Care.

#### Use of tactical tourniquet and forward transfusion

Among the medical procedures that the French military medical service performed for Prolonged Casualty Care, those concerning the management of hemorrhage are probably the most important since, this is the first cause of preventable death in military setting [16]. And as part of the TCCC, the use of tactical tourniquet and the forward transfusion are two life-saving interventions that significantly reduced the mortality rate by tackling hemorrhage [5].

Table 1: The 10 essentials Prolonged Casualty Care from Ball et al [9]

	1. Monitoring	2. Resuscitate	3. Ventilate and oxygenate	4. Control the Airway	5. Sedation and Analgesia	6. Physical Exam and diagnostics	7. Nursing and Hygiene	8. Surgical Interventions	9. Telemedical Consult	10. Package and Prepare for flight
<b>Minimum</b>	BP Cuff, Stethoscope, Pulse Ox, Foley	Fresh whole Blood kit	Bag-Valve-Mask with PEEP Valve	Awake Ketamine-Cric	Opiate Analgesics titrated through IV	Physical Exam without advanced	Clean, warm, dry, padded, catheterized	Chest tube, cric	Make comms, present patients and key witals	Be familiar with stressors of flight.
<b>Better</b>	Capnometry	2-3 cases of LR for Burn Resus	O2 concentrator	Long duration sedation	Sedation with Ketamine and option of midazolam	Ultrasound and point of care labs	Elevate head of red bed debride washout NG/DG	Fasciotomy debridement, amputation	Add labs and ultrasound video	Trained in critical care transport
<b>Best</b>	Vital Signs monitor	PRBS, FPF, Type specific donors	Portable Ventilator	Proficient un Rapid Sequence Intubation	Educated and practiced in multi drug sedation	Experienced and trained in above	Experienced in all nursing care concerns	Trained and experience in above	Real time video conference	Experienced in critical care transport
<b>Ruck</b>	Pulse Ox, head Lamp	1 FWB Kit per man, 2 250cc bag NS	BVM with PEEP valve	Cric Kit LMA/SGA, lidocaine and ketamine IM	Fentanyl TML, Perc PO, Ketamine IM/IV	Urinalysis test strips, fluorescein strips	Compact foley kit, Sterile kerlix, litter padding	Cric 10g Needle D Scalpel	Cell Phone and call sheet	Have checklist available
<b>Truck</b>	BP Cuff, Stethoscope, Capnometry, Small monitor	Casre LR, Additional FWB Kits, 3% Saline	SAVent or SAVE 2	RSJ, LMA/SGA, Cric kit ketamine bag IV	Ketamine IV with midazolam	Blood tubes to drop off labs on the way	Padded, litter, NG	Sterile chest Tube Kit with drapes	Celle Phone and call sheet, sat phone, radio	Checklist plus flight evac kit
<b>House</b>	Add defibrillation	2 additional cases LR, Cases NS, Additional 3% Saline	Impact Vent and O2 bottle	All from above Add Benzo if not available for truck	Same as above	Blood tubes to run labs to local clinic	Real mattress with head elevated nursing care kit sleeping Bag	Sterile surgical Kit with drapes, Gowns and scrub soap	Secure comms, email	Extensive evac kit
<b>Plane</b>	Take all of above	All of above	Impact vent on O2	All above calculate for flight and double	All above calculate for flight and double		Padded Litter, Sleeping Bag	10g needle D Chest tube kit Cric kit	Through aircraft	From above

In the study by Travers *et al*, 183 combat casualties. ¾ of the casualties were caused by an explosion. From the 183 casualties, 6% were killed in action, 4% died of wound. The tactical tourniquet was used for 18 combat casualties. In some cases, due to the ineffectiveness of the first one placed, another tourniquet was positioned higher than the first one. Travers *et al* found out that the median time for tourniquet application was 90 minutes (from 62 to 262 minutes) before withdrawal at the Role 2. In association with extended medical evacuation times, a tourniquet was applied for more than 120 minutes in six combat casualties. Complications possibly related to ischemia (rhabdomyolysis and compartment syndrome) were described for four casualties with a tourniquet application time longer than 120 minutes, and none when the tourniquet had been loosened in less than 120 minutes. Regarding forward transfusion, lyophilized plasma was transfused in nine casualties and red blood cells were transfused in four casualties before arriving at a Role 2. Transfusion was initiated a total of three times in the field, two times during helicopter medical evacuation, and five times during forward MEDEVAC. The failure to reconstitute lyophilized plasma was described in one case. No transfusion complications have been reported.

### What can be learned from this French experience?

Regarding the results of the two studies, it is clear that NATO standards concerning forward MEDEVAC in less than 60 minutes could not be met. Moreover, it highlights some major issues due to these extended delays. So, the application of a tourniquet for more than two hours is associated with higher rates of complications [14]. Among these complications, the most feared is limb ischemia [17]. Current French and international guidelines recommend re-assessing tourniquets as soon as the tactical situation allows it, and whenever possible to convert it to a simple local hemostatic packing [18]. The only contraindications to conversion are for patients with hemorrhagic shock, to avoid worsening shock in the case of rebleeding, traumatic amputated limbs, or, for some, a delay of over 6 hours following injury. The second crucial aspect of a Prolonged Casualty Care is the availability of blood product on the field. Indeed, whole blood and red blood cells storage is difficult. But the French military blood institute proposed the French lyophilized plasma, 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 [19]. More-

over only 62% of the casualties were transported to a Role 1 before the Role 2 which means that in 38% cases the medical team at the point of injury had to deal with the casualty with the minimal equipment they had [12]. And this justifies ongoing works on future medical vehicles, the miniaturization of devices for monitoring or oxygen therapy, or pharmaceutical storage, including blood products, in extremely hot or cold environments. But having a better equipment also implies having people well trained to operate it. This is a key element for Prolonged Casualty Care.

### The next steps for a good practice of Prolonged Casualty Care

Ball *et al* described 10 essential capacities for the good practice of Prolonged Casualty Care (see Table 1) [9]. Among those capabilities, some encompass basic medical skills received, at a minimum, in initial training but others require more experience and more skills. For example using ultrasounds for a diagnosis or performing advanced surgical interventions. From Travers *et al* study, the medical personnel reported that they wished they had more training for Prolonged Casualty Care. This means that more needs to be done for the medical team's preparation. The medical team doing Prolonged Casualty Care is wide ranging, from the first aid buddies to the surgical team in

a Role 2. Therefore, the training and preparation to Prolonged Casualty Care involve not only the physician but every level of care. For example, Travers *et al* reported that 80% of the prehospital care was done by a physician due to difficulties to access the point of injury. It implies that 20% of the prehospital care was performed by either a nurse, or even a first aid buddies trained to *Sauvetage au combat* [20]. This data highlights the importance of involving everyone for Prolonged Casualty Care training courses. Finally, one key aspect of Prolonged Casualty Care is the communication, in particular mentoring from medical experts [9]. That can be done with telemedicine [21]. The minimum is to call with our phone, but it could be better with the exchange of photos and videos, or it would be best to have real time audio and video feed to allow a remote diagnostic or guidance through a medical procedure.

## Conclusion

The way war is fought is evolving and so must the medical practices on the battlefield. Prolonged Casualty Care will not change the essential which is TCCC but now, more needs to be done. Indeed, military medical teams deployed in combat zones may have to deal with combat casualties on the battlefield longer. They will need to care for these casualties until these last ones reach a Role 2 and/or a medical treatment facility in a safer place, while ensuring that they are still able to receive more victims. This new temporality shows the limits of the current *golden hour* concept and the necessity to develop adapted protocols, including the management of tactical tourniquet for longer times and an easier access to blood transfusion. Despite this, some injuries like non-compressible torso hemorrhage will still require early specialized management, that would imply deployment of surgical teams closer to the frontline [22]. Finally, Prolonged Casualty Care is all about time and capabilities. If TCCC is acquired for most military medical services, French military medical teams need more dedicated trainings for Prolonged Casualty Care. To move forward, innovative collaborations with countries that have already developed capabilities in unconventional warfare such as the US, or Lithuania are possible [7] [23]. Training for Prolonged Casualty Care should be a point of major focus, with focus on adaptive solutions, in order to always do what is best.

Military medical teams need to be ready to operate in every situations, whether on ruck, truck, house or plane, with limited resources and a hostile environment.

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## Conflicts of Interest:

The authors declare that they have no conflicts of interest. The opinions or assertions expressed herein are the private views of the authors and are not to be considered as reflecting the official views of the French Military Medical Service.

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