MMSL
Military Medical Science Letters
Since 1925

Mil. Med. Sci. Lett. (Voj. Zdrav. Listy) 2026, 95(1), 22-32
ISSN 2571-113X (Online)
DOI: 10.31482/mmsl.2025.001

REVIEW ARTICLE

EFFECTIVE FORWARDED SURGICAL CARE IN THE ARMY OF THE CZECH REPUBLIC AND THE WORLD

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Received 15th September 2024.
Accepted 2nd January 2025.
Published 2nd March 2026.

Summary

This topic is probably the most important in the field of military healthcare in the long term, because care of this nature is the very reason why the whole sector was created. Effective forwarded surgical care is a crucial factor in reducing preventable battlefield casualties, known and developed since the historical beginnings of military healthcare. This highly demanding medical discipline is an absolutely essential component of the modern war effort, in which it takes on a whole new dimension thanks to unimaginable technological, medical and military-tactical progress. The changed character of the world's main battlefields seems to be crucial at present, with the return of conventional warfare accompanied by attacks on health workers. We stand before the next stage of challenges related primarily to the mobility and tactical capabilities of professionals providing this specific type of care. In the text, we have come out of the historical context that led to the evolution of this care into today's form, which we have analyzed in detail on the sample of the most advanced medical support of armies in the world. This example shows us the breadth and variability of these elements with regard to the various eventualities of their use. On this basis, we present the concept of systems providing this kind of care from both the global and the Czech Republic's point of view. At the same time, for understandable reasons, we pay close attention to the specifics of this type of care in Czech conditions.

Key words: special operations surgical team; damage control surgery; damage control resuscitation; operation in Afghanistan; war in Ukraine

Introduction

Providing adequate treatment to wounded warriors in a timely manner has been a challenge and a phenomenon of military healthcare since ancient times. At present, the United States undoubtedly has the most sophisticated system. The development of this highly specialized element can be traced throughout the 20th century. While Americans themselves would certainly have gone back to the Civil War era when they modified Larre's flying ambulances, the fact is that up to and including World War I, battlefield first aid was very chaotic and lengthy, contributing significantly to extreme casualties (1). These reasons certainly contributed to the fact that military doctors began to seriously think about how to work systematically and, above all, effectively with a large number of wounded on the battlefield (2).

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The Second World War thus already benefits from this shift in the understanding of the need for quality first aid in combat, which is well illustrated by the increase in the probability of survival of seriously wounded soldiers who get professional treatment by a medic from the First War 4% to an incredible 50% (3). In addition to new therapeutic means, such as blood plasma, albumin, or antibiotics, this drastic reduction in mortality was certainly due to the first truly sophisticated system of care for the wounded, including aeromobile transfers to field medical facilities, as well as the continuous improvement of patient care and the constant effort to create even better surgical procedures, or at least to optimize the existing ones (4).

The Americans subsequently used and further improved the hard-won experience from the world wars in the Korean War (1950 - 1953), when aeromobile transfer to Mobile Army Surgical Hospitals (MASH units) was a matter of course. A noticeable advance was that the organization of these workplaces made it possible to reach them by helicopter from the conflict zone in a matter of minutes. The change was absolutely fundamental. For those who reached the field hospital, the probability of survival was already 97.5% (5).

At the same time, this period is characterized by an incipient effort to solve the problem of the phase of transferring a seriously wounded soldier back to his homeland, which is so important from the point of view of prognosis, because field installations of even the highest type cannot fully replace the possibilities arising from the domestic environment (6).

Even during the Vietnam War (1955 – 1975), the average time it took a seriously wounded soldier to return to his homeland was 45 days. During the second war in Iraq (2003-2011), it was less than 4 days. (7).

Today's norm is to activate the Stratevac immediately after stabilization of the patient. In the Vietnam War, resuscitation first aid points were called Battalion Aid Station, and from there the stabilized patient headed back to the MASH unit (8). Although there is certainly a great deal of controversy on this topic, the authors believe that these "stations" were in fact the first advanced surgical workplace of a modern type in history (9).

However, the real basis for today's trend was laid by another situation. It was about the United States invasion of Grenada in 1983. During it, the Americans were able to build their MASH in up to 4 days, which might not seem like a bad performance in the case of a colossus consisting of 50 trucks, which develops 24 hours even in ideal conditions (10, 11). However, the delay in caring for the soldiers forced the army generals to change their philosophy and set out on the path of mobility and speed. The death knell began to ring for the classic MASH and its last deployment took place during the Gulf War (1990 - 1991) (12).

Subsequently, it was decided to prepare the concept of Forwarded Surgical Team (FST). The Americans had the first two "prototypes" ready in 1990, but the first really functional team was not available to the US Army until 1997. This team consisted of twenty people, from which it was possible to form two teams operating in parallel and caring for up to ten injured at the same time, who are usually postponed to a higher stage immediately after stabilization of the condition (13). However, what was the greatest asset of such a unit was its ability to disassemble all the equipment and start operating in a designated place in two tents within an hour and a half of arrival (14).

The first real test of the newly created concept was the landing at the Camp Rhino forward base in Afghanistan in 2001, when a modified detachment consisting of twelve people managed to treat forty-one wounded after bombing the second day after its deployment (15). It is very likely that this moment was crucial, because from this moment on, the use of forward teams has been massively expanded, and at the same time, due to the possible variability of composition, work on various modifications of the original concept has begun and Forwarded Surgical Teams are required in various forms for various places of military operation (16).

Further strengthening of health care occurred in 2009, when the US Secretary of Defense Robert M. Gates guaranteed care for wounded soldiers in the deployment area in the "Golden Hour" mode, which in practice meant a further expansion of the places of emergency care in the field and means of airmobile evacuation (17, 18). To date, there are fourteen active and twenty-three reserve Forwarded Surgical Teams (or Forwarded Resuscitation Surgical Team) (19). However, this is not the final number, as the Air Force and Navy also have advanced surgical

teams. However, it is evident that for the United States Armed Forces, numbering almost a million and a half soldiers on active duty, this is not a large number, resulting from the great mobility and flexibility of these elements (20).

The effectiveness of the system is confirmed by the recent experience of the conflict in Ukraine, where the American model was adopted and gradually modified according to the needs of a symmetrical bilateral conflict. This only confirms the high level of potential that lies in this system (25).

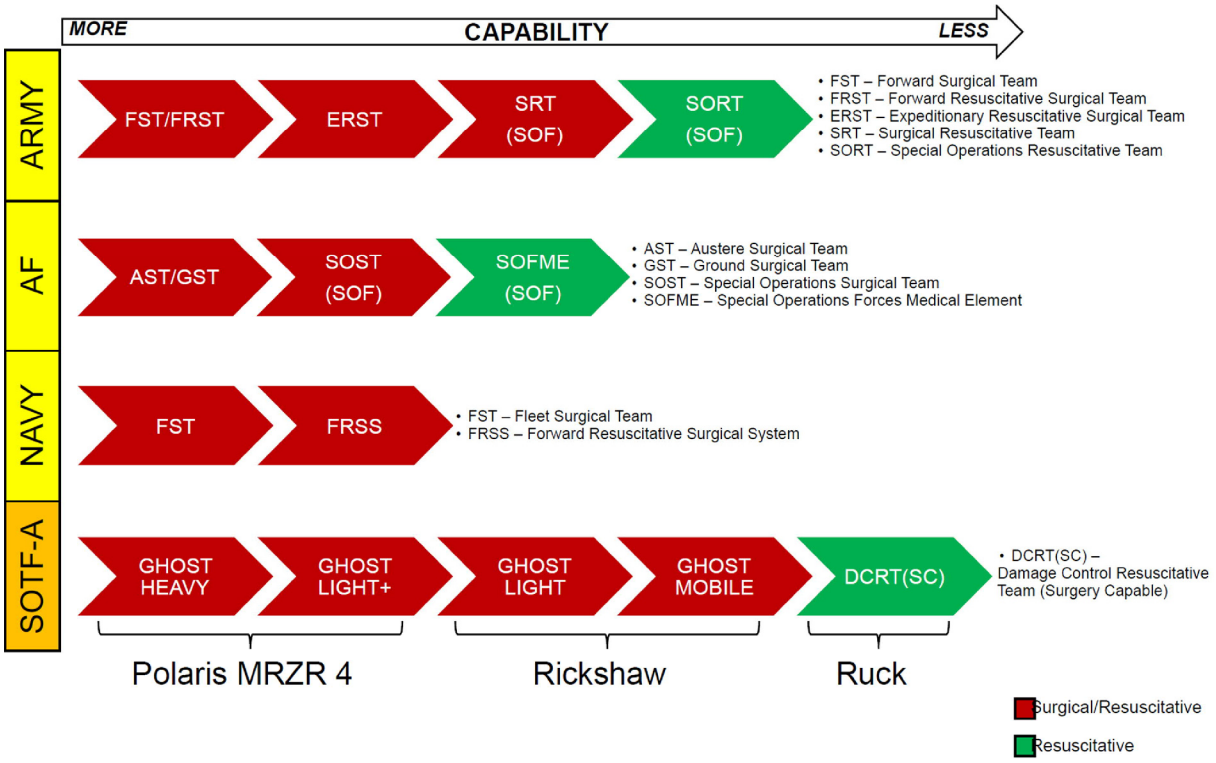

Figure 1. Ghost capes, U.S.Army unclassified capability brief of forwarded surgical team.

Structure of the American system, its composition and concept of teams – analysis (Figure 1).

Currently, American surgical teams are divided into three main groups: Air Force, Navy and Army. The Air Force named its basic building block GST (Ground surgical team). It is a stocking mobile unit usually used for various periods of time. Again, its base is most often a higher workplace, from where the team is sent, supplied and rotated in three-month intervals. If necessary, it is possible to allocate an element from these teams to support the Special Operations Surgical Team (SOST) or SOFME (Special Operations Forces Medical Element) (21).

The US Navy has recently revised its medical support and switched from the original FST (Fleet Surgical Team) capable of detaching FRSS (Forward Resuscitative Surgical System) to the concept of DCST (damage control surgical team) and ERSS (Expeditionary Resuscitative Surgical System) last year (22).

Since the basic philosophy of all three main groups is identical, we will base our analysis primarily on the U.S. Army model. The Army is based on the FRST (Forward Resuscitative Surgical Team), from which the subunit ERST (Expeditionary Resuscitative Surgical Team), SRT (Surgical Resuscitative Team), SORT (Special Operations Resuscitative Team) can be separated. To support Special Forces Operational Detachment Alpha (ODA), the GHOST (Golden Hour Offset Surgical Team) system was also created, which is directly subordinate to the Special Operations

Command. Smaller units are separated from FRSTs classified in this way, referred to by size as GHOST HEAVY, GHOST LIGHT+, GHOST LIGHT, GHOST MOBILE and DCRT-SC (Damage control resuscitative team – surgery capable). The standard is the dislocation of FRSTs at some field hospitals or at larger bases and the allocation of smaller groups to forward bases, according to their size and number of serving soldiers, as well as the frequency and probability of losses in connection with combat activities. Everything is provided both by medical supplies and by personnel from the parent FRST. Here, paramedics usually do not spend more than 3 months and are rotated back to higher workplaces. This staff turnover system has proven to be the most effective, both in terms of work performance and in terms of maintaining the expertise of all involved (23, 24).

The Forward Resuscitative Surgical Team is the cornerstone of forward care in the field of the US Army. If it is not located directly in a hospital or field medical facility, it is able to operate in almost any secure space designed for this purpose. The complete equipment is located in two iamion containers and it should not take a twenty-member team more than an hour and a half to unroll the tents with all the equipment. The team is divided into three sections. The first is two-member and is responsible for the operation and supply of medical supplies. The second, surgical, consists of four surgeons (ideally general surgeons and orthopaedists), two nurses specializing in acute conditions, two anaesthesia nurses, two general nurses and two military paramedics. The third section is resuscitation and consists of an urgent care doctor, an intensive care doctor, two intensive care nurses and two military rescuers. The entire element is designed for 72 hours of operation, during which it should be able to provide at least thirty surgical patients on two operating tables and five to ten intensive care beds without additional supply. If the replenishment of materials is provided (usually in the form of pre-packed bags – speedballs when taking over the injured for transport) and the rotation of the team, the length of its stay is not limited in any way.

The Expeditionary Resuscitative Surgical Team is a subunit separated from the Forwarded Surgical Team consisting of eight members – a surgeon, an orthopaedic surgeon, an emergency medicine doctor, an intensive care physician, an instrumentalist, an anaesthesia nurse, an intensive care nurse and an urgent care nurse. The whole element has one operating table and is designed for a maximum of two operations and two to three resuscitation patients, while this specific is the ability of long-term (in a matter of days) care for patients in locations where the available dislocation of higher workplaces for transfer and provision of further care is not well built - currently e.g. Africa. If the replenishment of material is provided (usually in the form of pre-packed bags – speedballs when taking over the injured for transport) and the rotation of the team, the length of its stay is not limited in any way.

The Surgical Resuscitative Team is the smallest military subunit detached from the Forwarded Surgical Team, consisting of four to five members: a surgeon, an emergency medicine physician, an anesthesia nurse, a paramedic, and a military medic. It has one operating table at its disposal, on which it is able to perform two to six procedures without additional supply, depending on their nature and complexity. Due to the small number of members and high mobility, these teams are sent for a short period of time to support the fighting units and send all their operators to the next stage. Since 2016, Expeditionary Resuscitative Surgical Teams have been formed on this basis, supplemented by intensive care specialists, whose domain, as mentioned above, is the ability to take care of a patient for up to several days in problematic locations.

The Special Operations Resuscitative Team is a unit used to care before/during the evacuation of wounded members of the Special Forces, consisting of eight members: a surgeon, an emergency medicine/intensive care physician, three military special forces medics, a radiology assistant, a nurse responsible for collecting and evaluating laboratory results, and an administrative and technical worker. The capacity of the team on one operating table is two to three procedures without additional supply. All members of surgical teams working with special forces must undergo a number of psychological examinations and preparations, as well as undergo military training so that they are able to secure the place of providing assistance. However, the reality is, of course, that it is completely undesirable to expose medical professionals to contact with the enemy, and the primary effort during planning is to make them as safe as possible.

GHOST HEAVY develops its workplace at the task execution point or on the forward base. This place of operation must be secured by the unit with which it operates, both in terms of adequate conditions (according to the length of deployment, accommodation, food...) and in terms of safety. The team consists of three to four surgeons (ideally general surgeons and orthopaedists), two instrumentalist, two intensive care nurses, two anaesthesia nurses

and two to three military paramedics. At the same time, they can take care of either one operant and two patients requiring resuscitation care, or two operants in parallel. A total of four operants or eight patients requiring resuscitation care without additional supplies. All team equipment must fit on two MRZR vehicles before being deployed in the transport vehicle, which can also serve as a means of evacuation for the transport of the wounded. If the replenishment of materials is provided (usually in the form of pre-packed bags – speedballs when taking over the injured for transport) and the rotation of the team, the length of its stay is not limited in any way.

GHOST LIGHT PLUS develops its workplace at the task completion point or on the forward base. This place of operation must be secured by the unit with which it operates, both in terms of adequate conditions (according to the length of deployment, accommodation, food, etc.) and in terms of safety. The team consists of one or two surgeons (ideally a general surgeon and orthopaedic surgeon), an instrumentalist, an intensive care nurse, an anaesthesia nurse and one or two paramedics. At the same time, they can take care of either one operant and one patient requiring resuscitation care, or a total of three operants, or six patients requiring resuscitation care without additional supplies. All team equipment must fit on one MRZR vehicle before being deployed in the transport vehicle, which can also serve as a means of transport for the injured. If the replenishment of materials is provided (usually in the form of pre-packed bags – speedballs when taking over the injured for transport) and the rotation of the team, the length of its stay is not limited in any way.

GHOST LIGHT develops its workplace at the place of the task or on the forward base. This place of operation must be secured by the unit with which it operates, both in terms of adequate conditions (according to the length of deployment, accommodation, food...) and in terms of safety. The team consists of one or two surgeons (ideally a general surgeon and orthopaedic surgeon), an instrumentalist, an intensive care nurse, an anaesthesia nurse and one or two paramedics. At the same time, they can take care of either one operant and one patient requiring resuscitation care, a total of two operants, or four patients requiring resuscitation care without additional supplies. All team equipment must fit on one stretcher before unrolling in the transport vehicle, and if the replenishment of materials is ensured (usually in the form of pre-packed bags - speedballs when taking over the injured for transport) and the rotation of the team, the length of its operation is not limited in any way.

GHOST MOBILE can transform the deck of evacuation vehicles such as the Boeing CH-47 Chinook helicopter or the Lockheed C130 Hercules aircraft into an operating room. During transport to higher departments, they can take care of either one operant and two patients requiring resuscitation care, or two operants or four patients requiring resuscitation care. The team consists of one or two surgeons (ideally a general surgeon and orthopaedic surgeon), an instrumentalist, an intensive care nurse, an anaesthesia nurse and a paramedic. All team equipment must fit on one stretcher (rickshaw) before unfolding in the transport vehicle.

Damage control resuscitative team – surgery capable is able to take care of two resuscitation care patients or one patient requiring life-saving surgery. The composition is a surgeon (ideally a general surgeon), an intensive care nurse, an anaesthesia nurse and a paramedic. They carry all their equipment only in backpacks and are thus highly mobile during military operations (Table 1).

Team	Personel	Surgeons	Patients*	Blood (W)	Weight**	Power	Packing
DCRT(SC)	4	1	2	6u	90 kg	0	Ruck
Mobile	4 (-6)	2	4	6(-10)u	160 kg	0	Rickshaw
Light	6 (-7)	2	4	10u	160 kg	0	Rickshaw
Light plus	6 (-7)	4	8	10(-20)u	1680 kg	1 (-3) kW	1x MRZR***
Heavy	10 (-12)	6	12	10 (-30)u	3360 kg	1 (-3) kW	2x MRZR

Table 1. Personal and equipment composition of forwarded surgical team.

* without resupply
** medical equipment only
*** an ultra-light turbo diesel combat vehicle Polaris Razor

The Ground Surgical Team is an essential element of the Air Force forward medical support. The composition is very variable (3-6), but the standard is six members – a surgeon, an emergency medicine doctor, an anaesthesiologist, an intensive care nurse and a technician – who should be able to care for ten patients in twelve hours without additional supplies, while three of these patients are able to provide intensive care, including ventilated beds. Due to its close connection to the air force and the use of transporting all material on air pallets to its destination, it is one of the most flexible operational teams. Two teams usually alternate on one task, where the first is located at the destination and performs the required activity and the second, alternating, is assigned to a higher role, where he acts as hospital staff.

The Special Operational Surgical Team is a subunit of GST, from which the most resilient individuals are selected based on strict criteria for direct cooperation with special forces. There are six members of these teams - a surgeon, a doctor of emergency medicine, an anesthesia nurse, an intensive care nurse, an instrumentalist and a respiratory therapist (a specialized medical professional trained in critical care) and, as already mentioned, their greatest asset is their declared ability To take care of yourself even in the demanding environment of special operations. The team should be able to perform two to ten procedures, depending on their nature and complexity, without additional supplies on one operating table.

The Tactical Critical Care Evacuation Team is an evacuation team consisting of an anesthesiologist - intensivist, an intensive care nurse and a respiratory therapist. Its task is to transfer patients after primary treatment to a higher workplace. The operating radius and the possibilities of the team depend on the specific place of placement, but as a whole it should be able to transport three patients in intensive care mode.

Tactical Critical Care Evacuation Team - Enhanced is an evacuation team capable of operations during expulsion. It is mainly used to help with a large number of injured people and insufficient capacity of forward workplaces. It consists of a surgeon, an emergency medicine physician, two anaesthesia nurses and an instrumentalist, and within its capacities it is capable of three to five procedures, depending on their nature and complexity.

Analysis of the Situation in the Army of the Czech Republic

Figure 2. Czech Special operation surgical team (CZE SOST) taking care of 2 patients.

In 2018, the training of Special Operations Surgical Team (SOST) began. This unique capacity of our army was certified in 2022 and the Czech Republic has become one of the few countries that have full coverage of potentially injured patients with top specialists and the most modern equipment available. It is a unique, combat ready, highly specialized, extremely mobile unit designed for effective medical support in difficult tactical or environmental conditions. The team can start working within half an hour after reaching the destination. It will gain full operational capability in 60 minutes. Of course everything depends on mission.

Teams of this type are able to plan and provide forwarded health care in the scope of DCR (Damage Control Resuscitation) and DCS (Damage Control Surgery) for the benefit of special forces operations with an emphasis on state-of-the-art procedures in the provision of urgent advanced care and the mobility of the element, as well as to provide ROLE 1 level care in special forces operations (triage of the wounded; urgent care for the critically ill in field conditions; life, limb, vision saving, stabilization of critically ill patients, laparotomy, thoracotomy, fracture fixation, amputation, fasciotomy, vascular reconstruction, decompression of cardiac tamponade and craniectomy; WBB activation; basic postoperative care and short-term hospitalization until postponement to a higher stage or for further treatment; ability to administer blood derivatives; selected imaging methods; basic laboratory examinations; administration of drugs; at least 15 surgical procedures in 72 hours and postoperative care for 4 patients for 6 hours at full development; reaching the destination and preparing facilities for the provision of advanced surgical and resuscitation care in a matter of hours, depending on transport capacity), and at the same time to ensure the personnel of the transport of the wounded (MEDEVAC within the operation, in cooperation with other units of the Czech Armed Forces STRATEVAC - transfer of the wounded to their homeland).

Figure 3. Full exposure of patient during medical examination.

SOST Medical Assistance Time Standards:

1. Advanced first aid – immediate life-saving measures (bleeding and airway control) immediately after injury.
2. Resuscitation stabilization of the injured within 30 minutes after the injury.
3. Surgical stabilization of the injured within 1 hour of injury.

Figure 4. Damage control resuscitation treatement.

Team equipment at maximum effort:

- Total volume approximately 20 m³
- Total weight approximately 2.5 t
- Required electrical input approximately 25 kW
- number of members: 8 (2x surgeon, traumatologist, anaesthesiologist, GP/urgent, 3x medic)

Team equipment with minimum commitment:

- Total volume approximately 2 m³
- Total weight approximately 250 kg
- Electrical power input 0 kW
- number of members 4 (surgeon, traumatologist, anaesthesiologist, medic)

Figure 5. Damage control surgery treatment.

Discussion

Given that more than two-thirds of soldiers falling into the KIA (Killed In Action) category die in the first ten minutes, the idea of saving them in combat conditions is very difficult. Progress in the field of pre-hospital care and interventions seems to be important, although in this group it is predominantly head injury and whole-body disability, i.e. a situation that is practically unsolvable and with a poor prognosis. However, the remaining group benefits significantly from the timely administration of resuscitation and surgical care, which is very well illustrated by the significantly decreasing number of casualties in Afghanistan after the introduction of the 10-1-2 rule (all wounded coalition soldiers receive first aid within ten minutes, resuscitation within an hour and surgical care within two hours) (1). Another fact supporting the need to introduce this type of care is the current experience of the conventional conflict between Ukraine and Russia, where long transport times for professional treatment cost the lives or health of tens of thousands to hundreds of thousands of soldiers on both sides. As part of prolonged care, the risk of infectious complications and septic conditions, which is a fatal complication in field conditions, also increases significantly (25).

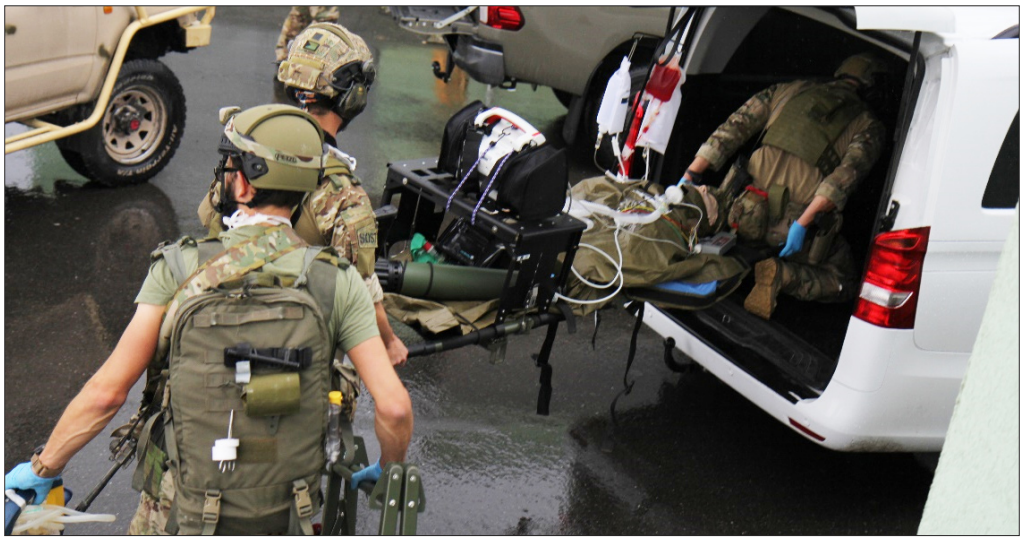

Figure 6. Transport of critical patient after forwarded surgical care.

Conclusion

Forward surgical teams have become an integral part of the world's battlefields in countless modifications with the development of the golden hour concept over the past decade. Although it was initially a privilege of special forces, today the deployment of all NATO and EU soldiers in the world is planned so that DCR and DCS are available in the shortest possible time window (24). The Czech Republic has so far been provided by partner nations, but current changes suggest that it will be absolutely necessary to take responsibility for our soldiers into our own hands, And that is why it is an amazing achievement that at the eleventh hour we gained this clearly differential capacity for survival.

The creation of a functional forwarded surgical care unit in the Czech Armed Forces has given enormous satisfaction to all those who have long pointed out the need to compare the capabilities of our military health care with western world. It is now necessary for this project, which brings together top specialists and state-of-the-art equipment, to continue to gain experiences and then pass them on to other groups through training to ensure adequate care for our soldiers wherever they need it.

Funding

Authors declare no financial support.

Conflict of interest statement

The authors state that there are no conflicts of interest regarding the publication of this article.

Adherence to Ethical Standards

Not applicable.

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