The French Advanced Course for Deployment Surgery (ACDS) called *Cours Avancé de Chirurgie en Mission Extérieure (CACHIRMEX)*: history of its development and future prospects

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Received 22 July 2015
Accepted 15 September 2015
Published Online First 13 October 2015

To cite: Bonnet S, Gonzalez F, Mathieu L, *et al*. *J R Army Med Corps* 2016;**162**:343–347.

ABSTRACT

Introduction The composition of a French Forward Surgical Team (FST) has remained constant since its creation in the early 1950s: 12 personnel, including a general and an orthopaedic surgeon. The training of military surgeons, however, has had to evolve to adapt to the growing complexities of modern warfare injuries in the context of increasing subspecialisation within surgery. The Advanced Course for Deployment Surgery (ACDS)—called Cours Avancé de Chirurgie en Mission Extérieure (CACHIRMEX)—has been designed to extend, reinforce and adapt the surgical skill set of the FST that will be deployed.

Methods Created in 2007 by the French Military Health Service Academy (Ecole du Val-de-Grâce), this annual course is composed of five modules. The surgical knowledge and skills necessary to manage complex military trauma and give medical support to populations during deployment are provided through a combination of didactic lectures, deployment experience reports and hands-on workshops.

Results The course is now a compulsory component of initial surgical training for junior military surgeons and part of the Continuous Medical Education programme for senior military surgeons. From 2012, the standardised content of the ACDS paved the way for the development of two more team-training courses: the FST and the Special Operation Surgical Team training. The content of this French military original war surgery course is described, emphasising its practical implications and future prospects.

Conclusion The military surgical training needs to be regularly assessed to deliver the best quality of care in an context of evolving modern warfare casualties.

Key messages

- The training of military surgeons has always been a priority for France.
- A comprehensive surgical training programme for military surgeons deployed abroad has been created.
- The Advanced Course for Deployment Surgery is a structured course that fulfils the needs of military surgeons prior to deployment.

INTRODUCTION

The French Military Health Service (FMHS) maintains a constant focus on the military surgeon's training since it is committed to deliver the best surgical care to its personnel in all types of military theatre of operation and environment. Since 1948, the French military surgeons—who deploy in a Forward Surgical Team (FST) (North Atlantic Treaty Organization (NATO) role 2)—work in a complementary '*tandem*', which includes an orthopaedic trauma surgeon and a '*generalist*' (or general) surgeon.[1] The general surgeon can be a subspeciality-trained visceral, thoracic, vascular or urological surgeon.[2] The understanding of pathophysiology in trauma and haemorrhagic shock, as well as the specifics of military trauma, requires a permanent adaptation of a military surgeon's training.[3]

Today, trainee French military surgeons follow the same surgical curriculum as their civilian counterparts, and thus, become more and more subspecialised from an early point in their career. However, these surgeons, competent in their field of speciality (and subspeciality), must also be able to manage modern military trauma, such as penetrating torso and limb injuries, which are extensively contaminated. They need to be familiar with damage-control resuscitation, damage-control surgery[4 5] and surgical triage in mass-casualty situations. They are generally not exposed to a significant volume of trauma during their training. Even though a new general surgery programme, which includes the teaching of traumatic emergencies, is about to be created,[6] no specific military French course based on trauma surgery management existed before 2007. Therefore, a comprehensive surgical training programme for surgeons deployed abroad (Advanced Course for Deployment Surgery (ACDS) called *Cours Avancé de Chirurgie en Mission Extérieure* (CACHIRMEX)) was designed and commenced by the FMHS Academy (FMHSA) (Ecole du Val-de-Grâce) in 2007. The aim of this course, like those offered in other nations, such as Germany (German Society for Trauma Surgery—DGU),[7] Switzerland (IATSIC/DSTC),[8] USA (American Trauma Society) and the UK (Military Operational Surgical Training (MOST))), is to give the specific skill set and knowledge that civilian training does not provide to deployable military surgeons. It deals specifically with military

penetrating injuries, blunt trauma (which sometimes predominates), non-traumatic emergencies and medical support to civilian populations in military healthcare facilities or austere environments. In NATO multinational operations, where pooling and sharing are becoming more frequent, this appears to be a powerful lever for interoperability. Since the creation of ACDS, its value has been confirmed by experience given the number and severity of injuries sustained by French soldiers and their outcomes. An analysis of the trauma cases operated on by military surgeons (assigned to the Medical Treatment Facility (MTF) (NATO role 3) in Kabul International Airport (KAIA)) who had recently graduated from ACDS showed that this training proved to be appropriate for the management of the sometimes complex wound associations encountered.[9 10]

This paper describes the content of this original French military war surgery course (ACDS) developed by the Ecole du Val-de-Grâce while emphasising the practical implications of this course and its future prospects for improvement.

COURSE DESIGN

Audience

The course is aimed primarily at military surgical trainees in their final year of residency. They will serve as visceral, orthopaedic, thoracic, vascular or urological surgeons during their military career. It is mandatory as part of their initial training, and the entire course must be validated at the end of their curriculum in order to graduate. It is also open—as part of the Continuous Medical Education (CME) programme—to the senior military surgeons, commissioned surgeons, reservist surgeons and civilian surgeons who request it. These senior military surgeons usually only attend certain modules of the course since their professional commitments, sometimes, limit their availability.

In addition, module 1 of the course (dedicated to the organisation of the French Medical Health Service (FMHS) during foreign deployment and not requiring surgical skills) is open to anaesthesiologists and more recently military emergency physicians.

Course composition

The entire course consists of five modules, each of three consecutive days, spread over two academic years. Each module lasts 20–24 h with a total of 112 h for the complete course (Table 1). The detailed ACDS curriculum is presented in Table 2.

Table 1 Content of the five modules

Module 1	Comprehensive overview of war wounds and the organisation of the FMHS during foreign deployments (20 h, including 4 h of practical demonstration and training with the FST equipment)
Module 2	Management of limb and soft tissues injuries (24 h, including 12 h of practical sessions on cadavers)
Module 3	Management of head, neck, cervical spine and thoracic injuries (24 h, including 8 h of practical sessions on cadavers)
Module 4	Management of abdominal and pelvic injuries (24 h including 8 h of practical sessions on cadavers). eFAST (8 h of lectures and practice)
Module 5	Medical support to populations in austere environments. Management of major haemorrhage (20 h, including 8 h practicing severe haemorrhage control on swine)

eFAST, extended Focused Assessment with Sonography for Trauma; FST, Forward Surgical Team; FMHS, French Military Health Service.

Each module is divided into three parts: presentations of recent deployment experiences, lectures and hands-on workshops.

The first part of each module is dedicated to a presentation of several surgical cases treated by a senior military surgeon who has recently returned from military operations. This post-deployment report is intended to be pragmatic and interactive through a step-by-step open questioning approach that includes individual '*Case Based Discussions*' (ie, '*at this stage, what would you do and why?*').

Academic lectures are didactic, adapted to different potential situations on the battlefield, the available equipment on the ground and the type of patients encountered, as well as the logistical capabilities. Three different situations are always considered: (1) the strategic aeromedical evacuation (STRATEVAC) to the French role 4 is easily available, (2) the STRATEVAC is delayed due to limited resources and (3) the STRATEVAC is not possible. This part of the course is also an opportunity for the FMHS to identify lessons and learn from them.

Practical sessions are designed to train each surgeon with the significant skill set and expertise deemed necessary to deal with complex situations, in particular life-threatening ones. These sessions are performed on fresh or embalmed cadavers and live tissue (anesthetised swine)—the latter used specifically to learn surgical control of major haemorrhage. The surgical equipment is identical to that available in the battlefield facilities. The '*tandem*' orthopaedic generalist surgeons assist each other during the practical sessions, as they would do when deployed. Student-to-cadaver or student-to-animal ratio is usually 2:1 and sometimes 3:1 depending on the number of attendees. The student-to-teacher ratio is usually 4:1.

At the beginning and end of each module, the students undergo the same 20-question online test to determine knowledge baseline and progression during the course along with the course's effectiveness. The faculty, in return, is evaluated by the students at the end of each module through a satisfaction survey on the course presentation and content. The survey responses are rated into four categories: below expectation, according to expectation, above expectation and outstanding. The course (five modules) runs every year. Students generally validate it over two academic years (modules 1 and 2 in the first year with modules 3, 4 and 5 in the second year). This gives them flexibility, and allows them to arrange individual module participation around other academic and hospital commitments. To fully validate the ACDS, military surgical trainees must (1) complete all five modules, (2) complete an 8-week rotation in a foreign deployed French FST (Africa—Chad, Djibouti or Ivory Coast) and (3) pass a final exam, which includes both a *viva voce* assessment (based on the multidisciplinary clinical management of a trauma case) and an oral literature update on a topic of interest to the student's surgical speciality. All the participants of the course are provided with an electronic copy of the course along with key references. Since 2011, the entire course, as well as the premodule and postmodule tests, is available online through the Ecole du Val-de-Grâce website GEDISSA platform (Gestion d'Enseignements à Distance et d'Information du Service de Santé des Armées) (http://www.gedissa.org).

Faculty

The Faculty consists of 27 professors from the FMHSA—15 military surgery, five head and neck surgery, four anaesthesiology and one each from medicine, biology and radiology. Thirty-one other FMHS lecturers and other subject matter experts also instruct on this course, including pharmacists,

Table 2 Advanced course for deployment surgery content

	Didactic lectures	Practical workshops
Module 1	Comprehensive overview on war wounded and organisation of the FMHS during deployment abroad ▶ War wounded: epidemiology, initial support, principles of damage-control surgery, special features of wounding agents, rules of triage and use of antibiotics in war wounds ▶ Organisation of the FMHS: levels of care, rules, principles of tactical and strategic aeromedical evacuation and health products supply ▶ Officer's course in foreign deployment, legal concerns on the battlefield	Demonstration and handling of technical equipment ▶ Presentation and assembling of an FST housed in tents ▶ Demonstration and handling of the equipments available in the FSTs (surgical equipment, principles of sterilisation and radiology)
Module 2	Management of limb and soft tissues injuries ▶ Burns: types of burns, dressing, escharotomy, fasciotomy, excision and skin grafting ▶ Soft tissue injuries: principles of debridement and negative pressure wound therapy ▶ Upper and lower extremity injuries: management of penetrating injuries, closed fractures and landmine foot ▶ Vascular injuries: epidemiology, diagnostic tools and choice of adequate treatment ▶ Compartment syndrome: therapeutic and preventive indications	Practical sessions on cadavers ▶ Wound debridement, skin grafting (manually operated dermatome), negative pressure wound therapy dressings, basic pedicle flap transfers and limb amputation ▶ Upper and lower extremity external fixation with PercyFx ▶ Upper and lower limb arteries approach (axillary, humeral, iliac, femoral and popliteal arteries) ▶ Fasciotomy (leg 4 compartments, forearm and hand)
Module 3	Management of head, neck, cervical spine and thoracic injuries ▶ Craniocerebral wounds and cranial trauma ▶ Spinal cord, ocular, face and neck injuries ▶ Wounds of the neck, larynx, trachea and oesophagus ▶ Open and closed thoracic injuries: indications and management of chest drainage and emergency thoracotomy	Practical sessions on cadavers ▶ Skull and face: burr hole trepanation, craniotomy, nasal packing for epistaxis and intermaxillary blocking ▶ Neck: cricothyrotomy, tracheotomy, subclavian and carotid arteries approach ▶ Thorax: anterolateral and clamshell thoracotomies, sternotomy, vascular control of descending thoracic aorta and cross-clamping, vascular control of major branches of the aortic arch and subxiphoid pericardial window ▶ Enucleation of the eye
Module 4	Management of abdominal and pelvic injuries, eFAST ▶ Thoracoabdominal injuries: penetrating and closed injuries, haemorrhagic shock, damage-control resuscitation and liver, spleen, kidney, duodenum, pancreas and digestive injuries ▶ Pelvic injuries: abdomino-pelvic-gluteal injuries, bladder, ureteral and urethral injuries and closed pelvic fracture ▶ Basis of eFAST	Practical sessions on cadavers ▶ Abdomen: organs approach, mobilisation and fascia separation, Pringle manoeuvre, perihepatic packing, vascular control of aorta and inferior vena cava, splenectomy, colostomy and laparotomy with negative pressure wound therapy dressings ▶ Pelvis: suprapubic cystostomy, ureteral double-J stent set up, pelvic external fixation, pelvic packing and internal iliac artery ligation ▶ eFAST: hands-on sessions between students
Module 5	Medical support to populations and management of major haemorrhage ▶ Reminder of severe abdominal (module 4), thoracic (module 3) and vascular (module 2) haemorrhage management ▶ Medical support to populations in austere environment: principles, ethics and specificity of care	Practical sessions on swine ▶ Temporary repair of haemorrhagic injuries: direct pressure, packing, vascular control and temporary shunt ▶ Definitive repair of haemorrhagic injuries: vascular repair and end-to-end anastomosis, venous bypass graft, suture of a lesion of inferior vena cava or portal vein and suture of a wound to the heart ▶ Laparotomy with negative pressure wound therapy dressing at the end of procedure

eFAST, extended Focused Assessment with Sonography for Trauma; FMHS, French Military Health Service; FST, Forward Surgical Team.

transfusion physicians, medical directors and emergency physicians, for deployment experience reports. Ten civilian physicians assist with the delivery of specific modules, such as paediatrics and feedback, from non-governmental organisation missions; 10 military support staff and two secretaries also support the faculty.

Practical organisation of the course

The organisation of the course is supported by several departments within FMHSA. The Department of Operational Medicine and Tactical Care plays an important role in providing the instructional equipment. The Health Products Supply Headquarters facilitates module 1 by providing FSTs housed in tents (role 2); it also provides the surgical equipment for the practical skills sessions (modules 2–5). The Operational Surgical Simulation Center provides the operating rooms and swine to train for major haemorrhage control (module 5). A specialised team of military support staff ensure that each animal is cared for, anaesthetised and euthanised at the end of each procedure according to the strict ethical and veterinarian policies in place. In addition, some civilian organisations facilitate the organisation of the practical surgical sessions on cadavers: the School of Surgery of the Assistance Publique—Hôpitaux de Paris (AP-HP) (module 2) and the European School of Surgery (Campus des Saints Pères, Paris) (modules 3 and 4). The course fee is €2000 per module per student.

COURSE RESULTS

From April 2007 to June 2014, seven complete cycles of five modules have been delivered (35 modules in total) to 174 trainees. The details of the attendees are given in Table 3.

Within the framework of initial operational surgical training, 68 junior military surgeons completed the course, of whom, 65 were French (29 in visceral surgery, 25 in orthopaedics, 6 in urology, 3 in thoracic surgery and 2 in vascular) and 3 were foreign students (one Gabonese thoracic surgeon, one Gabonese urologist and one Djiboutian urologist). To date, 60 French junior surgeons have graduated (92.3%). With respect to the surgical CME programme, 57 senior surgeons completed all or

Table 3 Details of ACDS course attendees: number of participants (number of graduates)

	Cycle 1 (2007–2008)	Cycle 2 (2007–2009)	Cycle 3 (2008–2010)	Cycle 4 (2009–2011)	Cycle 5 (2010–2012)	Cycle 6 (2011–2013)	Cycle 7 (2012–2014)	Total
Surgical initial training								
French junior military surgeons	9 (7)	9 (9)	11 (10)	8 (7)	10 (9)	8 (8)	10 (10)	65 (60)
Foreign surgical residents	–	–	–	1 (1)	–	1 (0)	1 (1)	3 (2)
Surgical Continuous Medical Education								
French senior military surgeon	1 (0)	4 (0)	–	3 (0)	3 (0)	1 (0)	–	12 (0)
Commissioned surgeons	3 (1)	–	2 (2)	–	–	–	–	5 (3)
Reservist surgeons	2 (1)	4 (2)	9 (1)	–	1 (1)	1 (0)	2 (0)	19 (5)
Civilian surgeons	–	–	–	–	2 (0)	3 (0)	3 (0)	8 (0)
Foreign surgeons	4 (0)	–	1 (0)	2 (0)	3 (0)	–	3 (0)	13 (0)
Medical attendees								
Residents in anaesthesiology	–	16 (0)	10 (0)	–	–	3 (0)	3 (0)	32 (0)
Emergency physicians	–	–	–	–	–	2 (0)	11 (0)	13 (0)
Reservists	–	–	–	2 (1)	1 (0)	1 (0)	–	4 (1)
Total	19 (9)	33 (11)	33 (13)	16 (9)	20 (10)	20 (8)	33 (11)	174 (71)

ACDS, Advanced Course for Deployment Surgery.

part of this course, of whom, 12 were enlisted surgeons (only attended one or two modules each), five were commissioned surgeons (of whom, three graduated) and 19 were reservist surgeons (of whom, five graduated). Thirteen foreign surgeons (from Mali, Benin, Morocco, Germany, Italy, Zaire and Senegal) and eight civilian surgeons belonging to the institution of preparation and response to health emergencies (Établissement de Préparation et de Réponse aux Urgences Sanitaires, EPRUS) completed the entire course. Forty-eight non-surgical trainees completed module 1, and were drawn from the following specialities: 32 junior anaesthetists, 13 battlefield emergency physicians, two senior anaesthetists and one reservist emergency physician. Over these seven complete cycles, the premodule tests revealed an initial average score of 51.6% good answers, increasing to 83.4% in the post-test. The students' evaluation surveys of the lecturers showed a 91% positive rating (above expectation or outstanding).

PRACTICAL IMPLICATIONS

The review of the curriculum in light of the case-based discussions from surgeons recently returned from operations has also led to changes in the operational equipment scaling, clinical guidelines and manning within the French FSTs.

In terms of the role 2 and 3 FST equipment scales, various changes have been made. A manually operated dermatome (named the Lagrot dermatome) has replaced the electrically operated one because of its lower cost and greater ease of maintenance within austere environments. The training of graft harvesting (grafts with regular edges and of constant thickness) was ensured during the cadavers' practical sessions of module 2. Ureteral double-J stents (the first was set up in September 2010 in the MTF (role 3) in KAIA), temporary vascular shunts (regularly used during the French deployment on Zaatari refugee camp in Jordan),[11] new surgical haemostatic agents and sealants (TachoSil) have also been added. Negative pressure wound therapy dressings have been added to role 2 and 3 equipment scales as well as military transport aircraft. As early as 2010, this allowed medical evacuation of war-wounded soldiers (from the KAIA MTF (role 3) in Afghanistan to our military hospitals (role 4) in Paris) with negative pressure wound therapy dressings in place over temporary laparotomies and/or the extremities. With regard to antibiotics, the need for standardisation drove the creation of a committee, including surgeons, anaesthetist–intensivists and biologists. In 2009, this committee created a guideline (which is regularly reviewed) for antibiotics in both prophylactic and curative uses during deployments.

In terms of manning, the FST still adheres to the format set up in the early 1950s of 12 personnel consisting of one each of anaesthetist, general surgeon, orthopaedic surgeon, scrub nurse and medical services support personnel, two general nurses and anaesthetist nurses and three assistant nurses.[1]

FUTURE PROSPECTS AND CME

To date, after seven full cycles of five modules, this course seems to meet the challenge of how to provide appropriate training for military surgeons, which is considered as a key point by many nations.[12 13]

The prospects for the future are numerous, but several specific points are planned:

- The production of an online manual for the course to be made available on the FMHSA website, which would be based on the model of the American manual, '*Emergency War Surgery*'.[14]
- Wider access of module 1 to other military hospital medical specialists and regimental physicians.
- The inclusion of the course in the CME curriculum for all surgeons (enlisted, commissioned or reservist) who qualified before 2007. This would be possible since all French physicians, whether they be civilian or military, must participate annually in a programme of CME.[15] Moreover, as deployments are becoming increasingly multinational, maintaining the highest level of expertise is the best way forward when interoperability, pooling and sharing are paramount.
- The wider opening of this course to civilian and reservist surgeons, specifically those who volunteer for the Institution of Preparation and Response to Health Emergencies since France deploys them to the front line in humanitarian assistance and disaster relief missions.
- Finally, for the future, the ACDS needs regular assessments and the creation of monitoring tools to determine the

necessary improvements to maintain the high standards of military emergency surgical care on deployment.

FROM INDIVIDUAL TO TEAM TRAINING

The ACDS course is aimed at training individuals. It is now recognised that the collective ability to effectively deliver trauma healthcare is a prerequisite to successful trauma management.[16] Hence, another training module was developed in 2012: the FST-ACDS training. This specific module, independent from the five ACDS modules, trains FST members to work effectively as a team. This team training is built around a standardised sequence that includes: reception and triage of simulated mass casualties; management of patients with massive haemorrhage using high-definition simulation mannequins and hands-on training on live tissues to familiarise the team with the management of patients with massive haemorrhage trauma using the same equipment that will be available in the battlefield facilities.

In addition, a further team-building module, specific to the surgical unit, which is designed to support special forces (Special Operation Surgical Team) was constructed. This is based on the management of patients with massive haemorrhage using either high-definition simulation mannequins or swine. This very light and mobile life-saving unit, consisting of one each of general surgeon, anaesthetist, anaesthetic nurse and scrub nurse, was conceived to provide damage-control resuscitation and damage-control surgery for two critically injured casualties.[17 18]

CONCLUSION

The ACDS (CACHIRMEX) is a structured course that fulfils the needs of military surgeons prior to deployment. It prepares them for the treatment of military penetrating blast and blunt trauma as well as non-traumatic emergencies and the provision of care to civilian populations in military healthcare facilities that are located in austere environments. This course is based on a combination of lectures, reports of deployment experiences and practical (cadaver and swine live tissue) workshops. It militates against the lack of major trauma exposure that affects military surgeons, who are often working predominantly in the civilian sector, by giving them a wide range of skills and expertise to prepare them for treating complex military trauma. It is now fully integrated into the curriculum of French military surgeons. The next step is to open up the course to military physicians in non-surgical specialities. Tools will be designed to ensure ongoing quality improvement of this original course through appropriate and regular audit of its delivery and effect.

Acknowledgements We gratefully acknowledge and sincerely express our appreciation to Surgeon Commander Simon Leigh Smith, Consultant in Emergency and Pre-Hospital Emergency Medicine, Royal Navy, Pilot French Medical Liaison Officer for Royal Navy for reviewing the manuscript and rectifying the remaining Gallicisms.

Contributors All the authors had contributions in drafting or revisiting the manuscript and approved the present version. SB, FG, SR and FP have contributed to study design and writing of the manuscript. LM, GB, EH and AB have contributed to data acquisition. J-PA, XD, FR and PB have contributed to analysis and interpretation of data.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

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